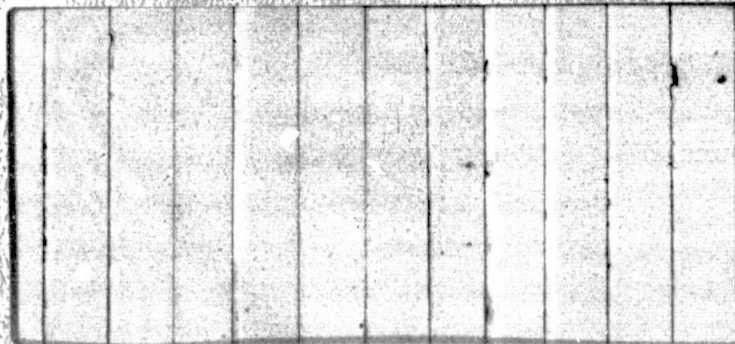


General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

CR 151659



(NASA-CR-151659) MULTIPLEXER/DEMULTIPLXER
FLEXIBILITY ENHANCEMENT PROGRAM Final
Report (Sperry Flight Systems, Phoenix,
Ariz.) 186 p HC A09/MF A01

N78-20427

CSCI 09C

Unclas

G3/33

11815



PHOENIX, ARIZONA 85036



NASA Contract No. NAS9-15359
DRL No. T-1363
Line Item No. 8

FINAL REPORT

MULTIPLEXER/DEMULTIPLEXER FLEXIBILITY
ENHANCEMENT PROGRAM

FEBRUARY 27, 1978

Prepared by:

SPERRY FLIGHT SYSTEMS
PHOENIX, ARIZONA

Prepared for:

NASA/Johnson Space Center
Houston, Texas

TABLE OF CONTENTS

	Page
INTRODUCTION	1
1. Design	1
A. Chassis Design	1
B. Module Design	7
Pulse Output 28-Volt (P028)	
Sequence Memory (SEM)	
Other Module Modifications	
C. Thermal Design	17
2. Fabrication	21
A. Chassis Fabrication	21
B. Module Fabrication	26
General Features	
Pulse Output 28-Volt (P028)	
Sequence Memory (SEM)	
Power Supply (P/S)	
C. Hybrid Circuits	32
D. Sequence Memory Programmer	38
E. Sequence Memory UV Eraser	42
3. Test	42
A. Performance Test Specification	42
B. Functional Demonstration	44
C. Acceptance Test Procedure	44
4. FMDM Thermal Study	45
APPENDICES	
I. Hybrid Analysis Data Sheet - D028 CONTROL 3A	
II. Hybrid Analysis Data Sheet - D028 DRIVER 2	
III. Schematic, Hybrid Substrate and Hybrid Assembly Drawings - D028 CONTROL 3A	

- IV. Schematic, Hybrid Substrate and Hybrid Assembly Drawings -
D028 DRIVER 2
- V. Analysis of +12-Volt MIA Regulator for Application to Sequence
Memory
- VI. Analysis of -5-Volt Sequence Memory Regulator
- VII. Flexible MDM ATE Test Output
- VIII. Listing of Paper Tape Data Used to Program Sequence Memory
- IX. Listing of Sequence Memory Contents from Data Bus
- X. Flexible MDM Acceptance Test Procedure Computer Output
Listing
- XI. FMDM Thermal Study

INTRODUCTION

This final report summarizes the accomplishments of the NASA/JSC MDM Flexibility Enhancement Program, Contract NAS9-15359 as carried out by Sperry Flight Systems from April through December 1977. It includes discussion of major Statement of Work tasks and the results, conclusions and recommended actions.

All tasks called out in the amended SOW were carried out. Significant development tasks which were completed included the following:

- Development, breadboard and test of a Pulse Output 28-Volt (P028) Module.
- Development and test of a 32-channel DC Analog Input (DCIN) Differential Module.
- Development and test of a sequence memory module using an M2708 EPROM which can be programmed in the unit.
- Development and test of a radiator top cover for a radiation-cooled Flexible MDM.

The configuration control and field test support study tasks were eliminated early in the program and are not addressed.

All elements of the "Report, Engineering and Technical Data, Pulse Output Hybrid Design Definition" are also contained herein. The hybrid design analysis for D028 CONTROL 3A is in Appendix I, while D028 DRIVER 2 is in Appendix II. Hybrid substrate, schematic and hybrid assembly drawings for the D028 CONTROL 3A hybrid are in Appendix III while those for the D028 DRIVER 2 hybrid are in Appendix IV.

I. Design

A. Chassis Design

ORIGINAL PAGE IS
OF POOR QUALITY

The Flexible MDM design is based on concepts, materials and processes currently in use in avionics products of Sperry Flight Systems. In particular, technology from the Space Shuttle Orbiter MDM and the Solid Rocket Booster MDM is used directly.

All materials and processes selected meet the requirements of MIL-E-5400 and have been previously approved on similar avionic equipment. Workmanship criteria are based on the requirements of MIL-STD-454.

The design concept is the result of an integrated design approach extending from the detail electronic components through the chassis. This approach results in controlled thermal management paths within the unit structure while weight is minimized, and at the same time reliability and maintainability features are optimized.

The Flexible MDM, shown in Figure 1, contains 13 shop replaceable assemblies: 12 plug-in modules which form easily removable assemblies by virtue of captive fasteners; one power supply module; and one wire-wrap motherboard assembly. The module plugs directly into the motherboard which is mounted horizontally along the bottom of the chassis. The power supply module is mechanically secured to the chassis to provide structural support and a direct thermal conduction path.

The top and bottom covers employ captive fasteners. The external connector arrangement on the front of the unit is optimized for easy hook-up and removal. The identification plate is mounted on the side of the front panel.

Careful attention has been given to design flexibility and equipment growth features. In the electronic module design, physical construction, component partitioning and card sizing make the module readily adaptable to

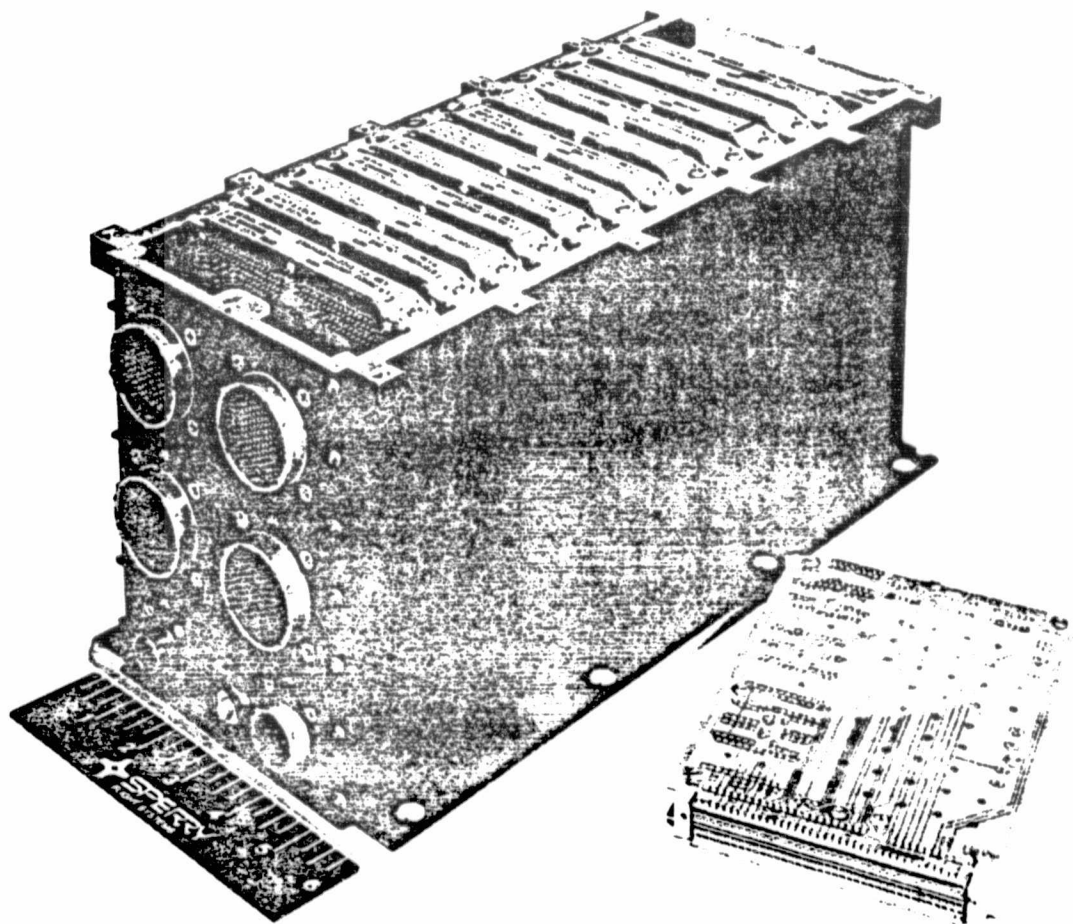


Figure 1
Chassis Assembly

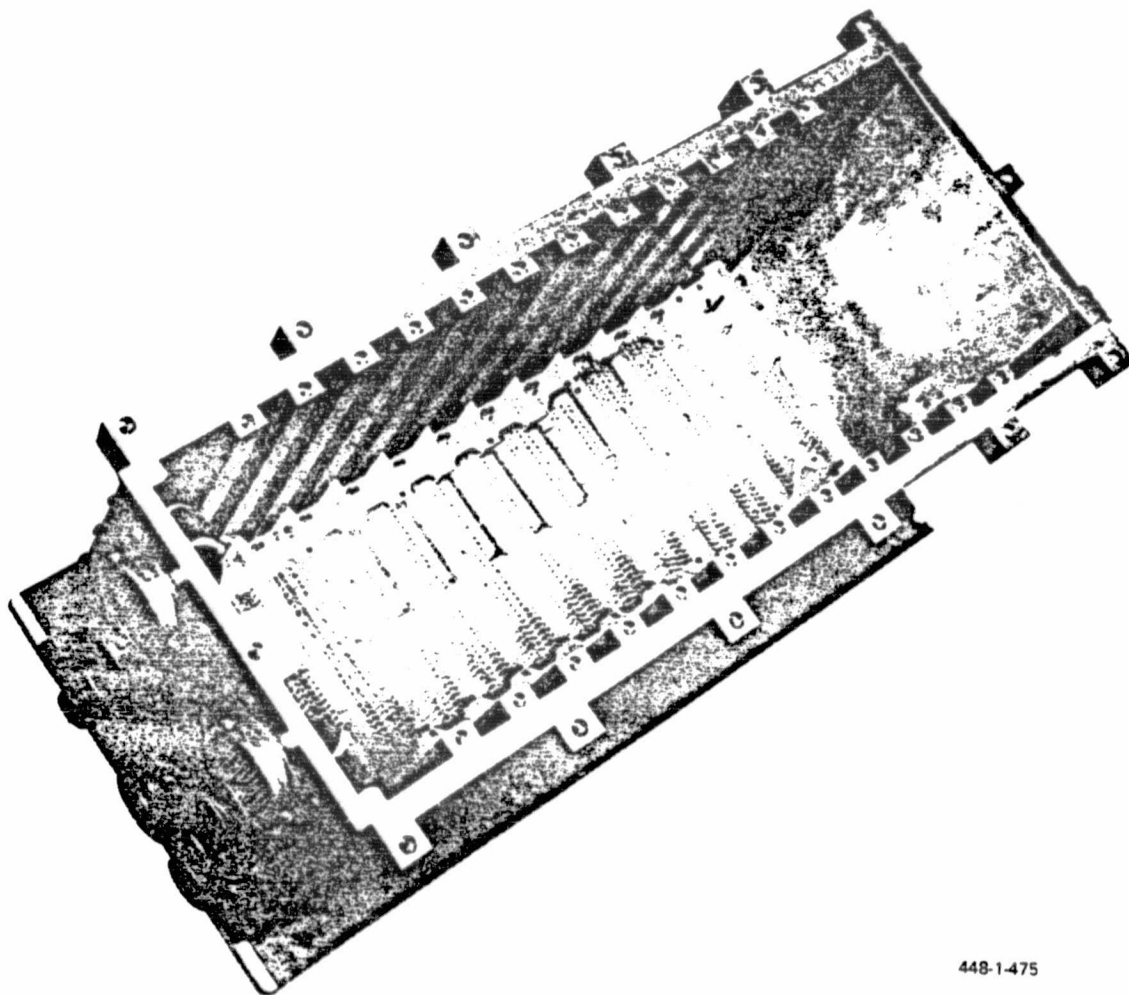
ORIGINAL PAGE IS
OF POOR QUALITY

electrical design modifications. Maximum design flexibility is provided in the interconnection between modules in the chassis through the utilization of wire-wrap techniques.

The internal design features of the Flexible MDM chassis, shown in Figure 2, have been optimized from the standpoints of weight, volume, structural rigidity, thermal management and human factors. On the front surface of the unit, connectors, pressure relief valve and nomenclature have been sized and located to provide the maximum maintainability without a sacrifice in equipment weight or volume. The single bay contains the required number of plug-in modules and an enclosed power supply mounted at the rear of the chassis. Captive fasteners secure each module, providing structural rigidity and optimum thermal management contact coefficients. A separate motherboard in the bay provides a highly flexible means of interconnection.

Provisions for equipment growth include space for additional components on the module boards, spare connector pins and additional space in the harness wiring. In addition, the chassis structure is adequately sized to accommodate additional loads, and thermal management paths are sufficient to properly cool the equipment at the maximum operating condition.

High-density equipment such as the Flexible MDM requires a large number of input/output and module-to-module signal interconnections. Wire-wrap has been selected as a flexible means of providing these interconnections. Developed shortly after the end of World War II, wire-wrap has advanced to become the most reliable termination available today. In addition, wire-wrap offers excellent flexibility for design modifications, improved field maintenance, low weight, and high packaging density. The contacts of the



448-1-475

Figure 2
FMDM Internal Packaging Features (Chassis Assembly)

ORIGINAL PAGE IS
OF POOR QUALITY

wrapplate will accommodate up to two wire terminations. All wire-wrap terminations conform to MIL-STD-1130 and NAS 2695.

A multilayer printed wiring motherboard is utilized to provide additional interconnection between modules.

The harness is bundled, tied and supported by several strategically located clamps on the motherboard. By utilizing the proper fixtures, the harness is formed in the same configuration as used in the equipment, thereby eliminating any potential for tight wires and assembly handling problems. When installed in the equipment, changes to the harness can easily be accomplished without removal. Therefore, removal and handling of the motherboard, harness and unit connectors will be minimal.

Because of its excellent thermal characteristics and cut-through resistance, polyimide-insulated wire conforming to MIL-W-81381 is used throughout the equipment.

Two covers complete the chassis enclosure. Both feature an environmental gasket, retained hardware, and are ribbed to provide high strength with minimum weight.

In summary, the design features of the chassis include:

Rugged Construction - Structural parts are machined from wrought aluminum plates. Special attention has been paid to joint designs and fastener selection to assure strong, RFI-tight joints with outstanding durability.

Low Weight - The unit weight is minimized consistent with environmental requirements. The design has been carefully assessed to eliminate unnecessary material and is based on extensive tests of the Orbiter MDM and SRB MDM.

Efficient Cooling - Conduction heat transfer paths are designed into the modules and chassis structure to transfer heat energy from the components to the ambient or mounting surface.

Easy Maintenance - Access to the electronic subassemblies or chassis wiring is by removal of the appropriate top or bottom cover. Each cover is fitted with captive fasteners. In addition, each module is keyed to prevent improper insertion.

Environmental Protection - In order to survive the environments specified for transportation, ground handling, and storage, the Flexible MDM will be an environmentally sealed unit. This will include the use of cover gaskets, connector gaskets, connector caps, and a pressure relief valve.

B. Module Design

Pulse Output 28-Volt (PO28) - The PO28 design provides +28 volt DC pulsed signals to the Space Shuttle payload. Pulse width is from 20 to 35 msec. This module provides 48 pulsed outputs selected by the SCU and organized as three 16 bit channels. All outputs are in the reset mode when not being commanded by the SCU. Each channel has an independent reset insuring independent operation of each channel. Upon command from the SCU the reset of the selected channel is released and the commanded outputs are set. Within 20 to 35 ms after the commanded outputs are set the reset will be reapplied automatically, turning the outputs off and supplying the correct width output pulse.

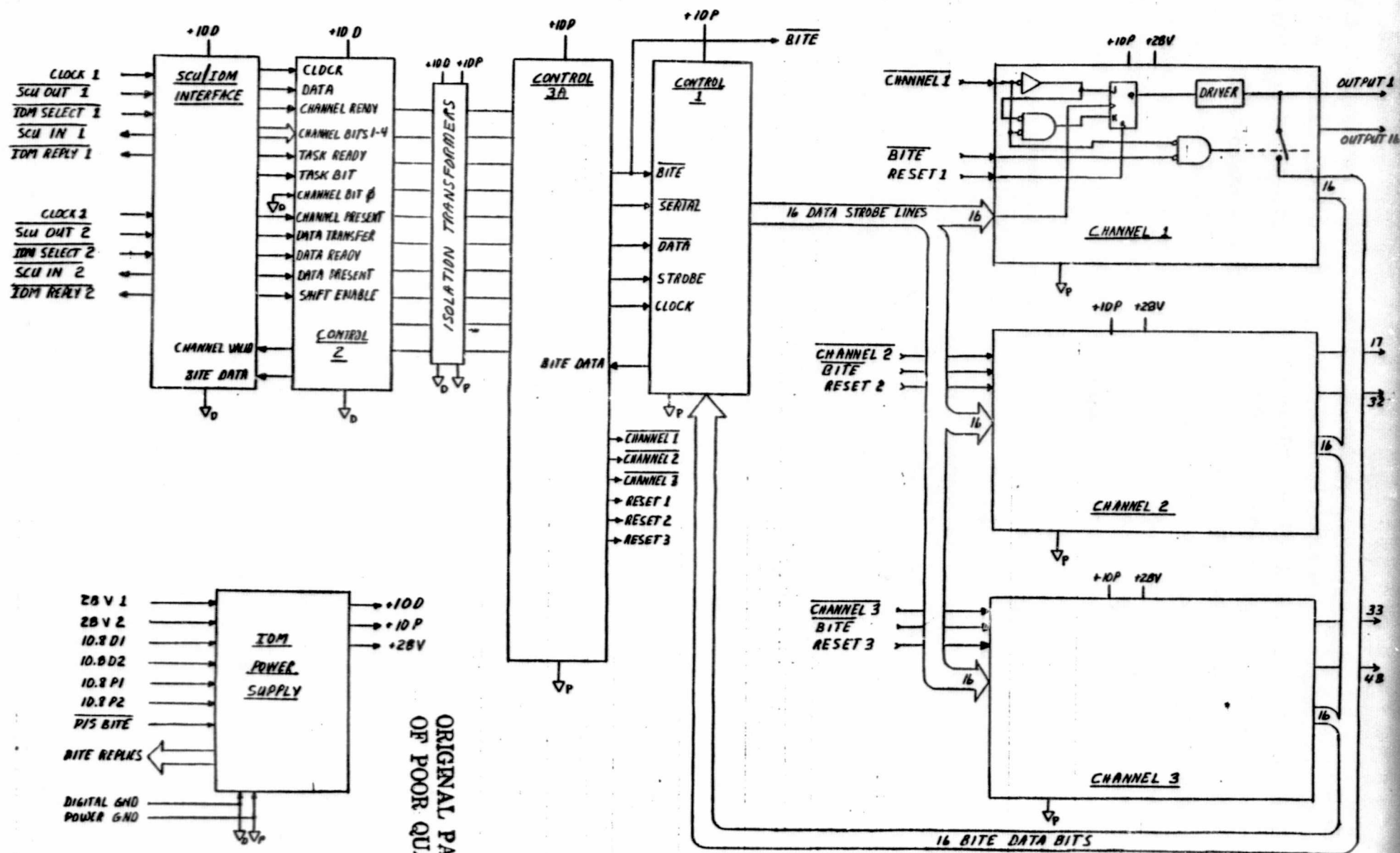
The outputs are non-retriggerable and pulse width will not exceed 35 ms. The drivers are capable of supplying 50 ma at a minimum of 18 volts dc. The drivers, because of additional current capability, have no short circuit protection. It should also be noted that, because of power limitations, no more than 24 outputs may be set at one time with a maximum duty cycle of 20%.

BITE is provided in this module in the form of one response data word for each channel. The response data word consists of the previously commanded outputs as long as the BITE is executed within 20 ms after the outputs are commanded. The response data word is compared to the commanded output to verify P028 operation.

Figure 3 is a block diagram of the P028 module. Figures 4 through 7 are schematic diagrams of the P028 module and show hybrid interconnection and discrete circuitry.

The P028 module was tested over a range of temperatures from -20°C to $+100^{\circ}\text{C}$. Results of this test are shown in Table I.

New hybrids used in the P028 design that are different from D028 include the D028 CONTROL 3A and D028 DRIVER 2. Circuit analysis of these hybrids as carried out by the Sperry Microcircuit Engineering group is shown in Appendices I and II respectively. In addition, hybrid substrate, schematic and assembly drawings for the D028 CONTROL 3A hybrid are in Appendix III while those for the D028 DRIVER 2 hybrid are in Appendix IV.



ORIGINAL PAGE IS
OF POOR QUALITY

Figure 3

PULSED OUTPUT
28V: BLOCK
DIAGRAM

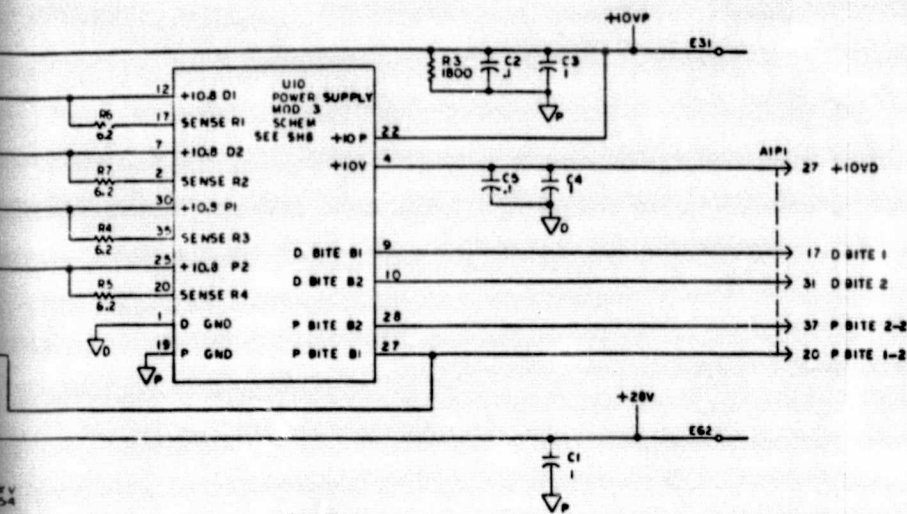
FOLDOUT. FRAME 1

Figure 4. Schematic Diagram - Pulse Out 28-Volt (P028)

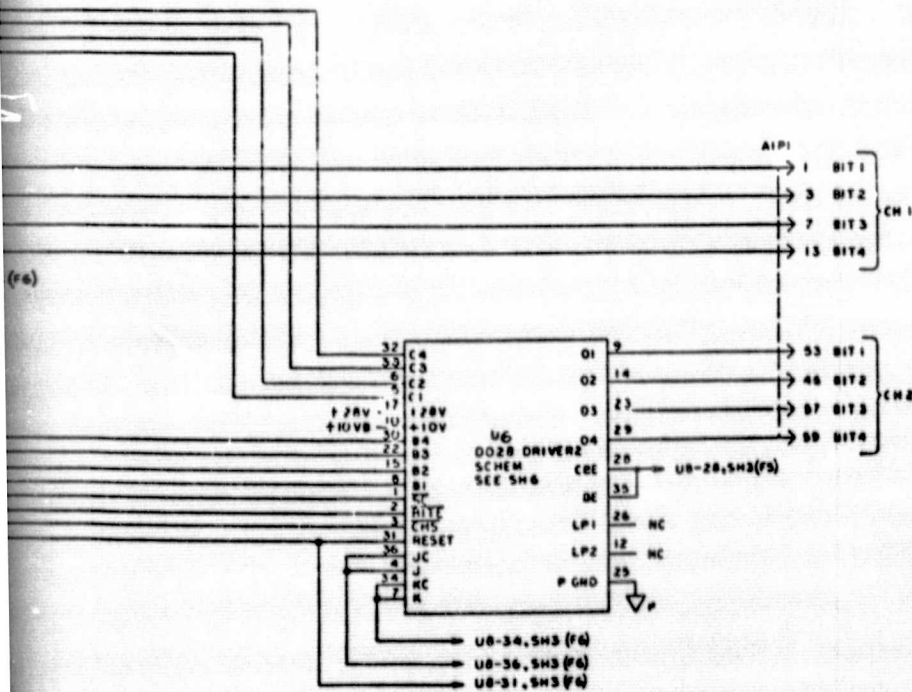
AI - Sheet 2

Figure 4. Schematic Diagram - Pulse Out
28-Volt (P028)

FOLDOUT FRAME 2



REDUCED SIZE
DO NOT SCALE



Schematic Diagram - Pulse Output
28-Volt (P028)

AI - Sheet 2

P/O AI CARD



FOR CONTRACT NUMBER,
OTHER APPLICABLE,
SEE FIRST SHEET

SIZE: P/O AI
E 07187
4033917-901

FOLDOUT FRAME

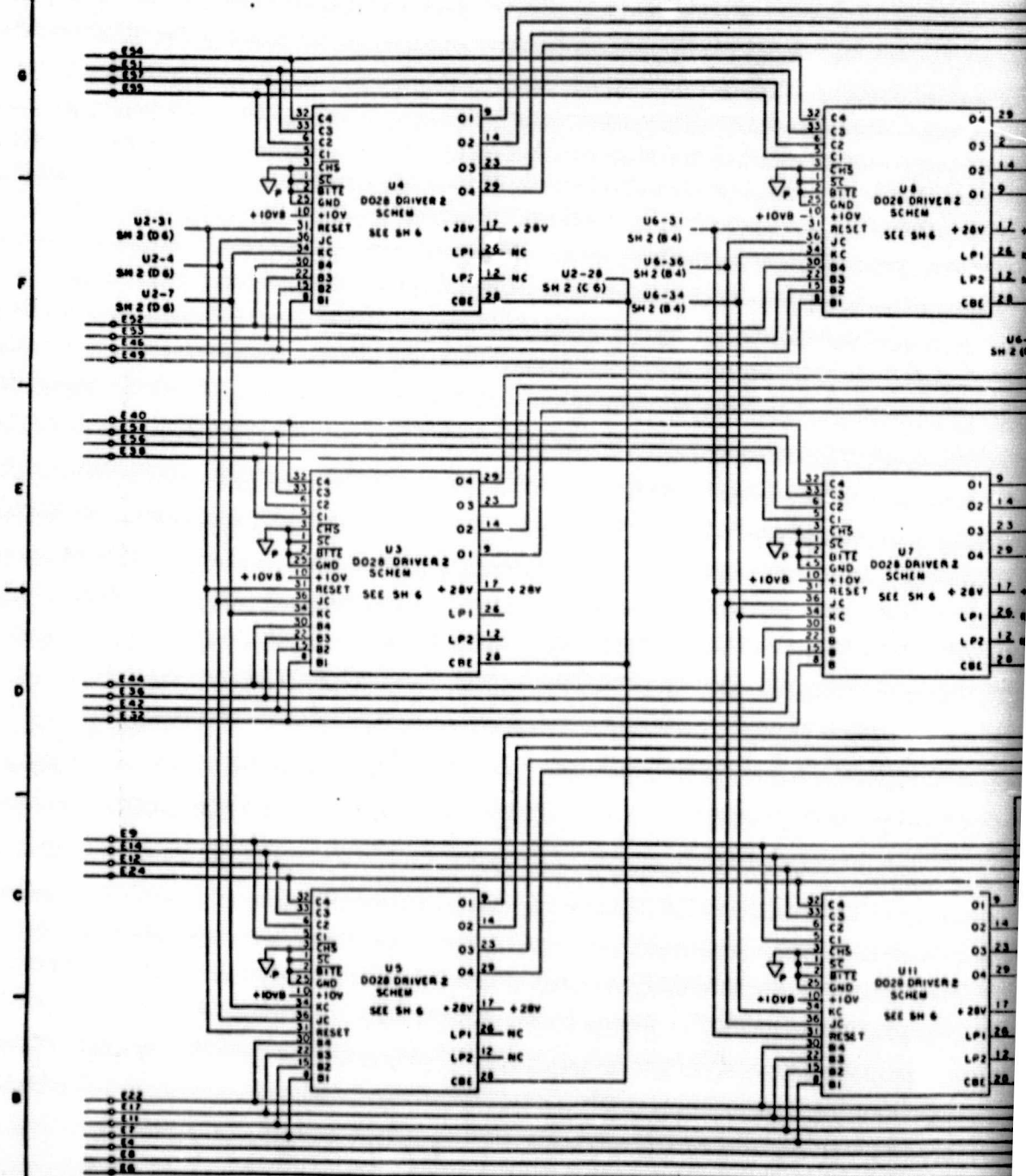
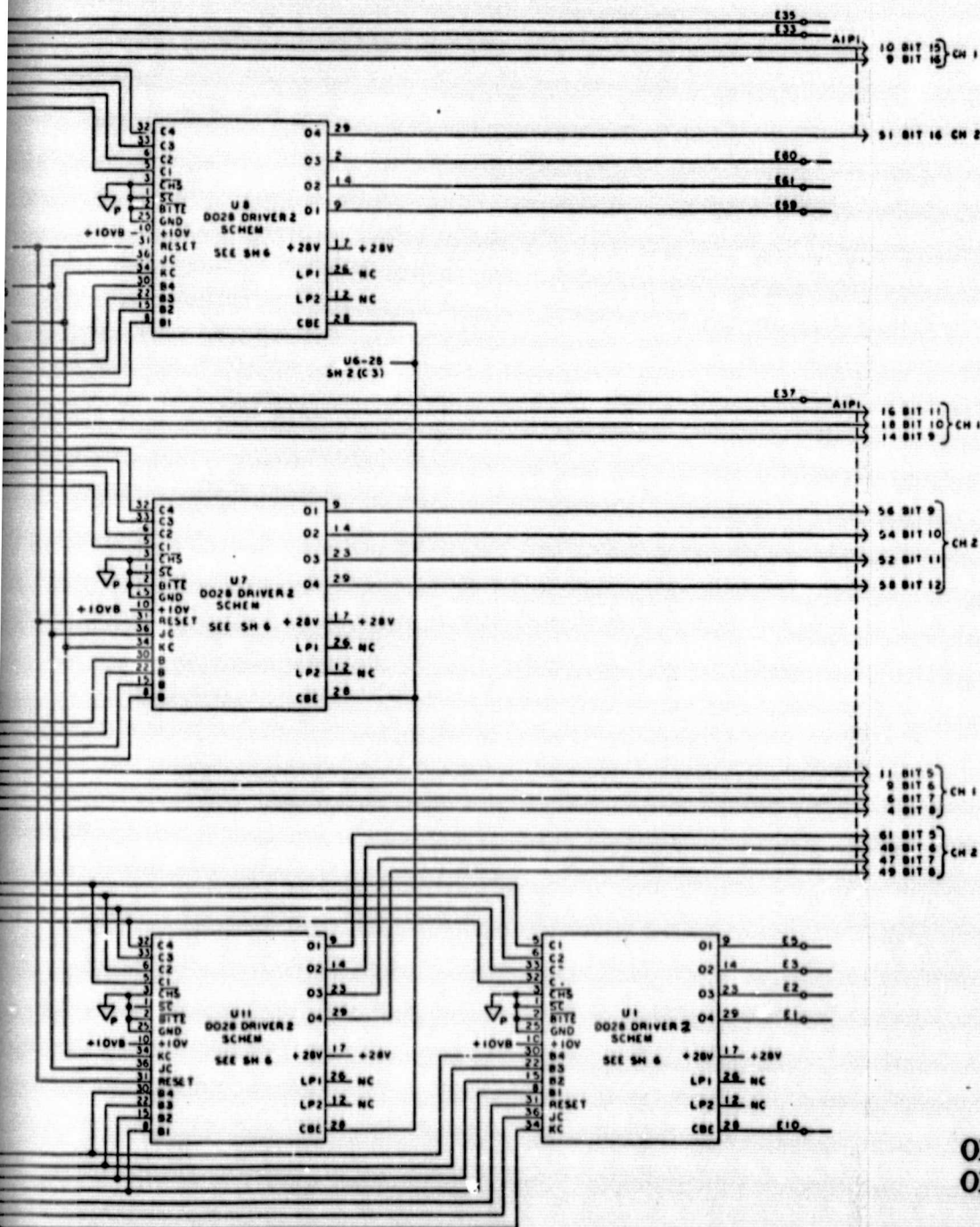


Figure 5.

POURBOUT FRAME
2



REDUCED SIZE
DO NOT SCALE

ORIGINAL PAGE IS
OF POOR QUALITY

Figure 5. Schematic Diagram - Pulse Output 28-Volt (P028)

A1 - Sheet 3

P/O A1 CARD



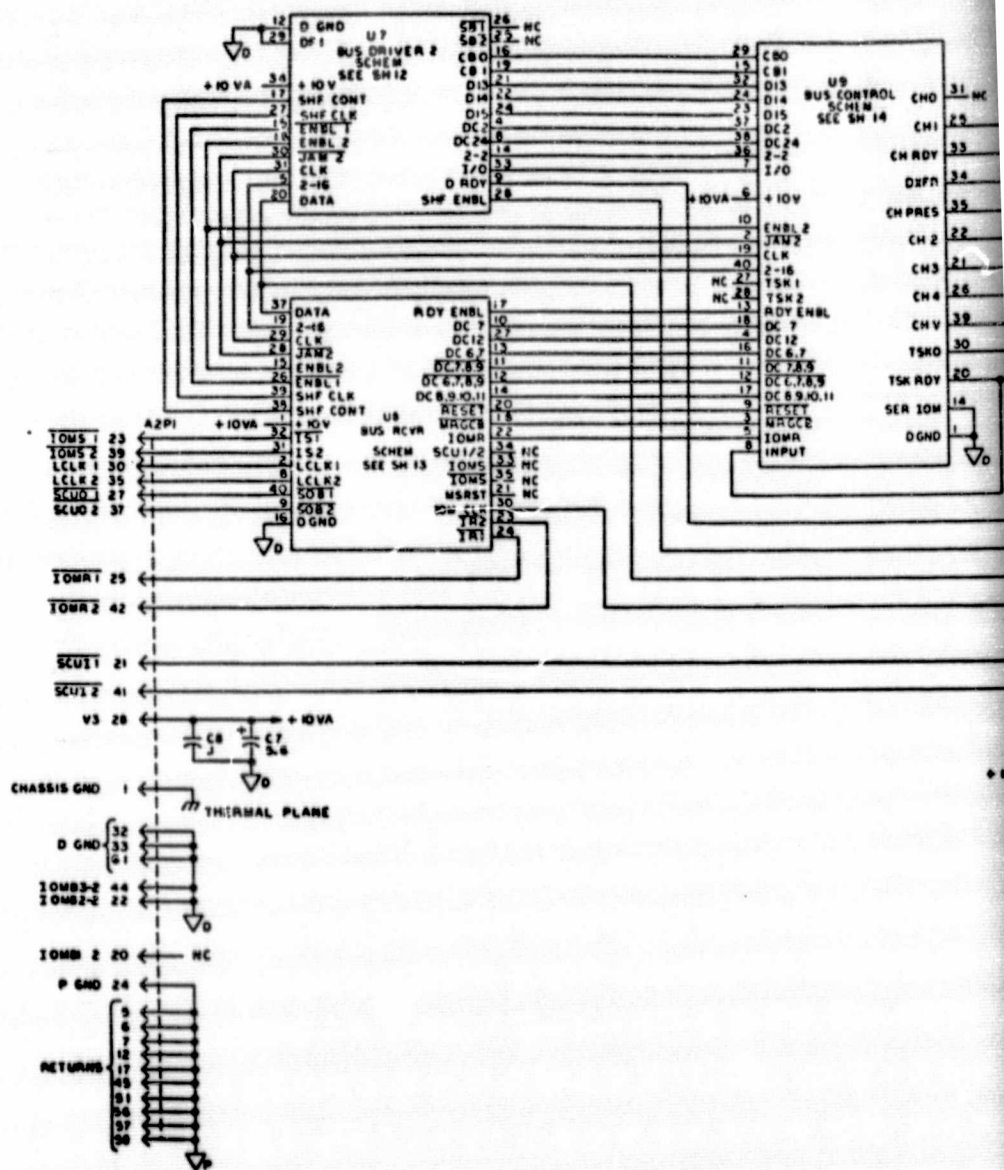
FOR CONTRACT NUMBER,
ORDER AND PRICE,
SEE FIRST SHEET

SIZE: 17x11
E 07187

SHIPPING NO:
4033917-901

SHEET 3

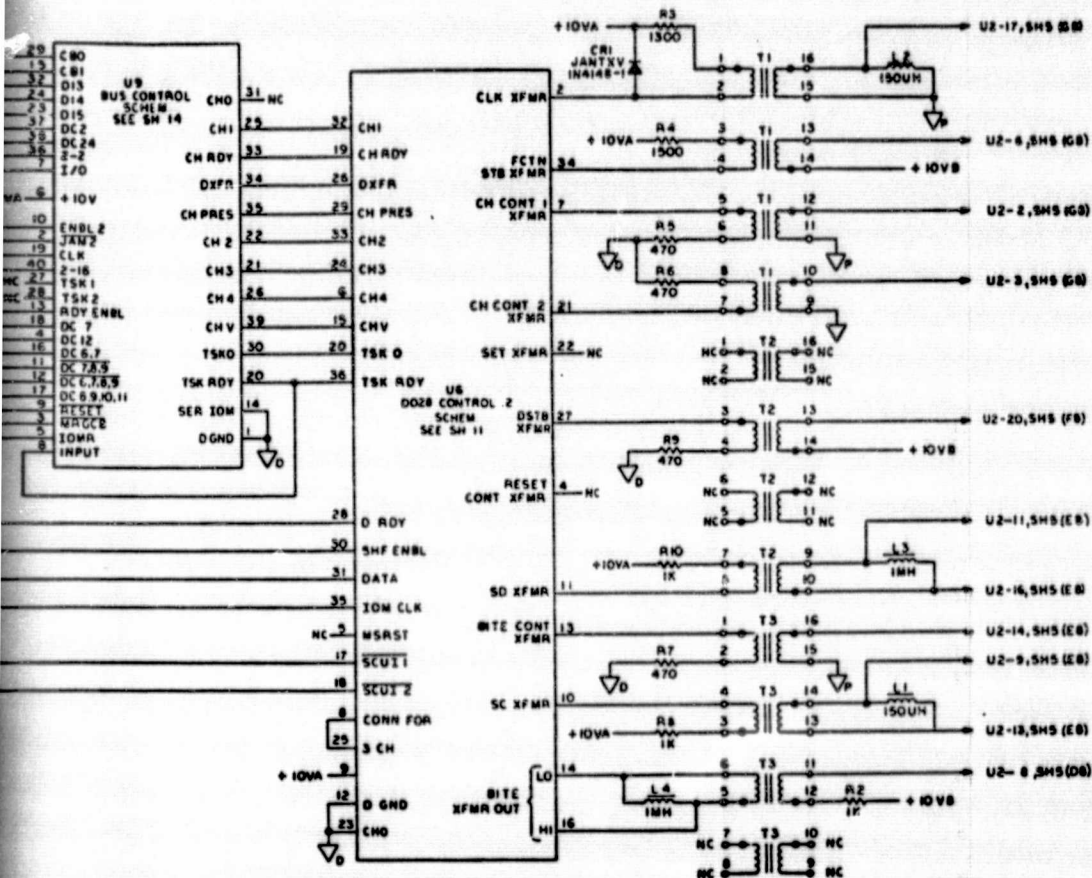
POLE-OUT FRAME



NOTE:

1. AS CONNECTOR PINS 10, 19, 26, 29, 31, 34, 36, 38, 40, 43 AND 46.

Figure 6.



POLECOOT FRIDGE

2

REDUCED SIZE
DO NOT SCALE

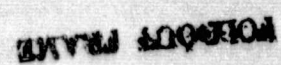
ORIGINAL PAGE IS
OF POOR QUALITY

Figure 6. Schematic Diagram - Pulse Output 28-Volt (P028)

A2 - Sheet 4

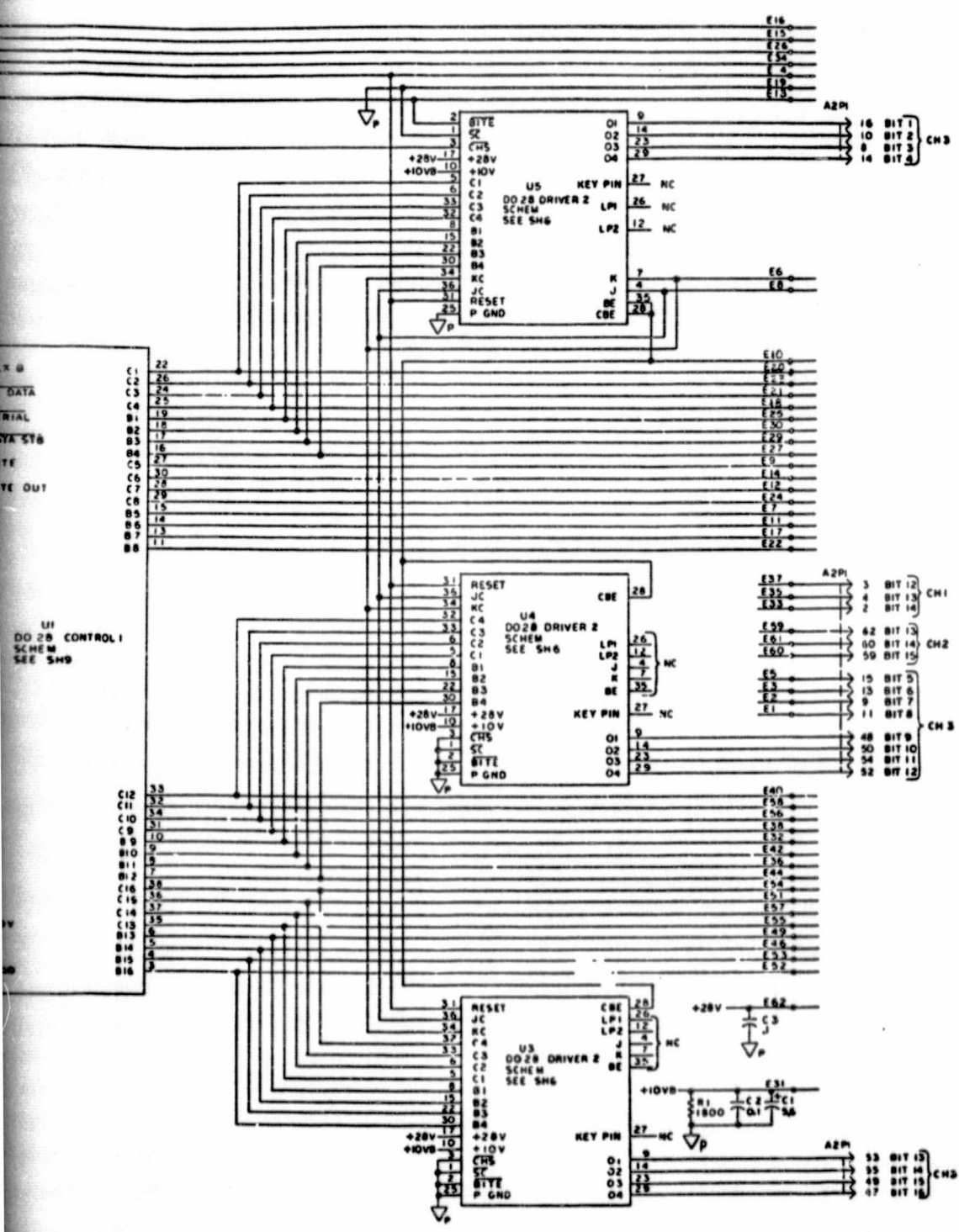
P/O A2 CARD

	FOR CONTRACT NUMBER, ORDER AND CABLE, SEE FIRST SHEET	DESIG. NO.	DRAWING NO.	REV.
		E 07197	4033917-901	1
SHEET 4		SHEET 4		



Figure

FOURTH FRAME
2



REDUCED SIZE
DO NOT SCALE

ORIGINAL PAGE IS
OF POOR QUALITY

Figure 7. Schematic Diagram - Pulse Output 28-Volt (P028)
A2 - Sheet 5

P/O A2 CARD

TABLE I
PULSED OUTPUT 28V
THERMAL TEST

The P028 breadboard was tested from -20°C to +100°C and no problems were encountered. The following is the data recorded during this test. Input voltage to the drivers was 26 VDC.

CH2 BIT 1

TEMP (C°)	PULSE WIDTH	RISE TIME	FALL TIME	OUTPUT VOLTAGE
-20°	29.8 ms	16 μs	65 μs	23.5V
0°	28.2 ms	15.5 μs	68 μs	23.7V
+25°	26.8 ms	14.8 μs	70 μs	24.0V
+50°	26.4 ms	13.8 μs	76 μs	24.0V
+75°	26.5 ms	13.3 μs	82 μs	24.0V
+100°	26.3 ms	13.0 μs	93 μs	24.0V

CH3 BIT 1

TEMP (C°)	PULSE WIDTH	RISE TIME	FALL TIME	OUTPUT VOLTAGE
-20°	28.8 ms	16.2 μs	55 μs	23.8V
0°	27.5 ms	15.2 μs	58 μs	24.0V
+25°	26.0 ms	14.0 μs	60 μs	24.0V
+50°	26.0 ms	14.0 μs	69 μs	24.0V
+75°	25.7 ms	13.5 μs	75 μs	24.0V
+100°	25.5 ms	13.0 μs	83 μs	24.0V

ORIGINAL PAGE IS
OF POOR QUALITY

Sequence Memory (SEM) - The Sequence Memory module (SEM) provides for the indirect mode of command for the FMDM. Upon receipt of a PROM sequence command, the SEM will be accessed and perform the required preprogrammed sequence.

The SEM circuitry consists of an M2708 EPROM and associated circuitry for interfacing with the Sequence Control Unit (SCU) as shown in Figure 8. The M2708 uses three power supplies: +12V, +5V, and -5V. During normal operation in the read mode, +12V is obtained from the +12V MIA regulator, +5V is obtained from the core P/S, and -5V is derived from the core P/S's -13.2V by an onboard regulator on the SEM. The EPROM may be programmed while the SEM is still installed in the FMDM by connecting a PROM programmer to the J5 connector of the FMDM. When being programmed, the SEM obtains all needed electrical signals and power from the external PROM programmer. To erase the EPROM, the SEM must be removed from the FMDM and subjected to the proper ultraviolet source.

All signals to and from the M2708 are TTL compatible. The SN5407 interface circuitry is power strobed and all unused inputs are grounded to insure minimum power dissipation in the SEM.

Appendices V and VI show calculations verifying worst case operation of the +12V and -5V regulators. The +5V from the core P/S is also used for powering TTL in the SCU and therefore will also satisfy M2708 requirements.

Other Module Modifications - Unlike the Orbiter MDM, the Flexible MDM has interchangeable IOM's. The IOM's may be interchanged with no other changes to the unit. In order to accomplish this, several changes were made

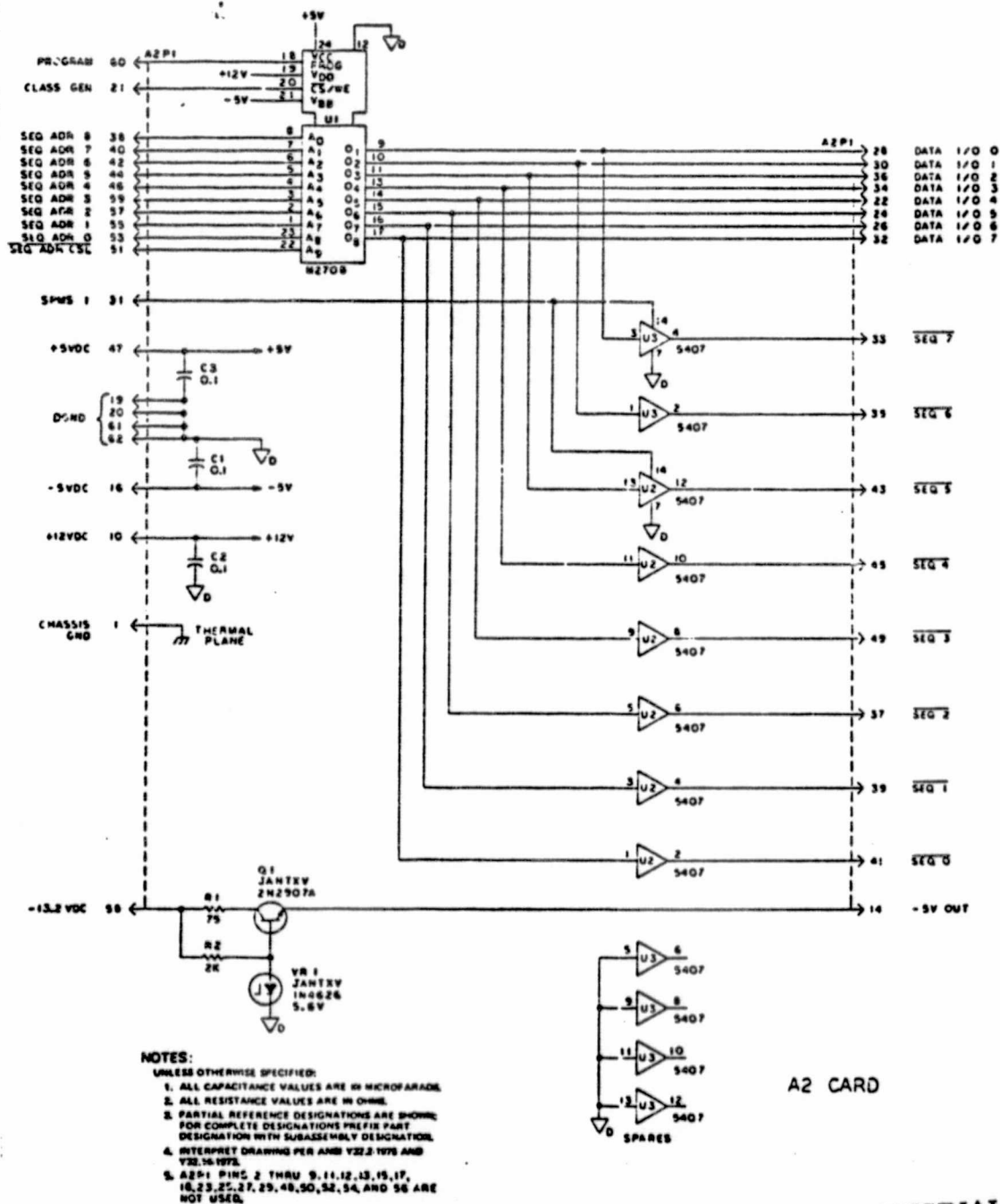


FIGURE 8
 SEQUENCE MEMORY SCHEMATIC DIAGRAM
 (FROM DRWG NO. 4033906-901)

to core modules and IOM modules.

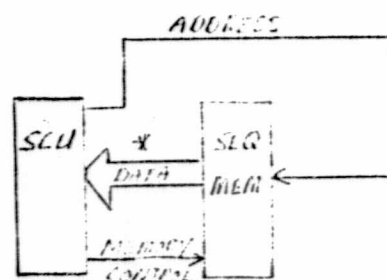
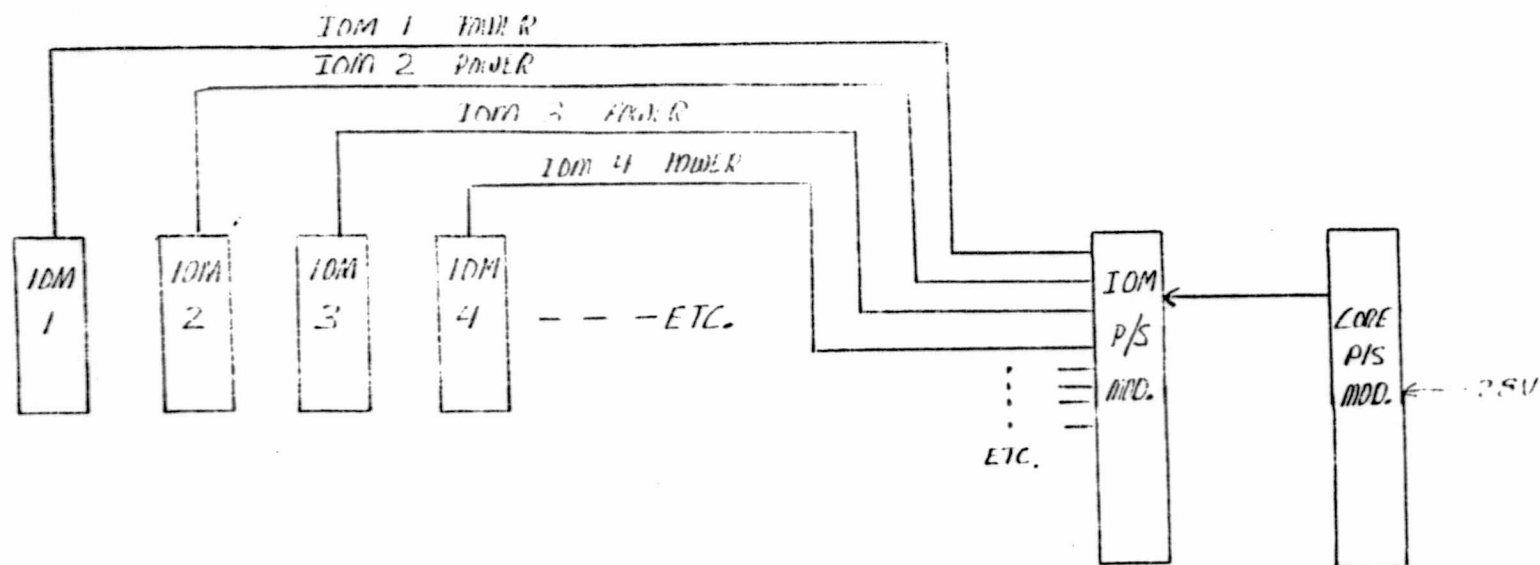
To accomplish IOM interchangeability, the IOM power supplies are incorporated into their respective IOM's and module mix information is no longer programmed into the sequence PROM's but is incorporated into the IOM's. Multiplexing circuitry has been added to the MIA modules to channel this module mix information from the IOM's to the SCU. Figure 9 shows the original non-flexible Orbiter MDM architecture, while Figure 10 shows the Flexible MDM design. In order to accomplish the above changes, module height was increased by 0.6 inches and the SCU and MIA were redesigned to make room for the additional circuitry.

C. Thermal Design

Sperry has long recognized the contribution of efficient thermal design to overall reliability. To that end, an extensive capability for analysis, design, and testing has been developed.

The basic approach to the assembly design is that of providing an integrated thermal path from the heat-dissipating component to the cooling surface. The construction of the circuit card assemblies provides a carefully designed conduction path from the components to the chassis. In turn, the chassis forms an integral part of the thermal management system by providing a direct conduction heat transfer path to the vehicle cold plate as shown in Figure 11.

Heat energy dissipated by devices mounted on circuit card assemblies is transferred to a copper thermal plane below the device. The heat is then conducted along the thermal plane to the aluminum frame, then directly to the module-chassis interface. Dimensional tolerances, widths and thickness are carefully controlled at this interface to maintain a minimum temperature differential across the junction and to avoid using special thermal grease or filler compounds.



*SEQUENCE MEMORY DATA INCLUDES MODULE MIX DATA, TEST TABLE AND SEQUENCE DATA.

FIGURE 9

ORBITER MDM ARCHITECTURE (SIMPLEX)

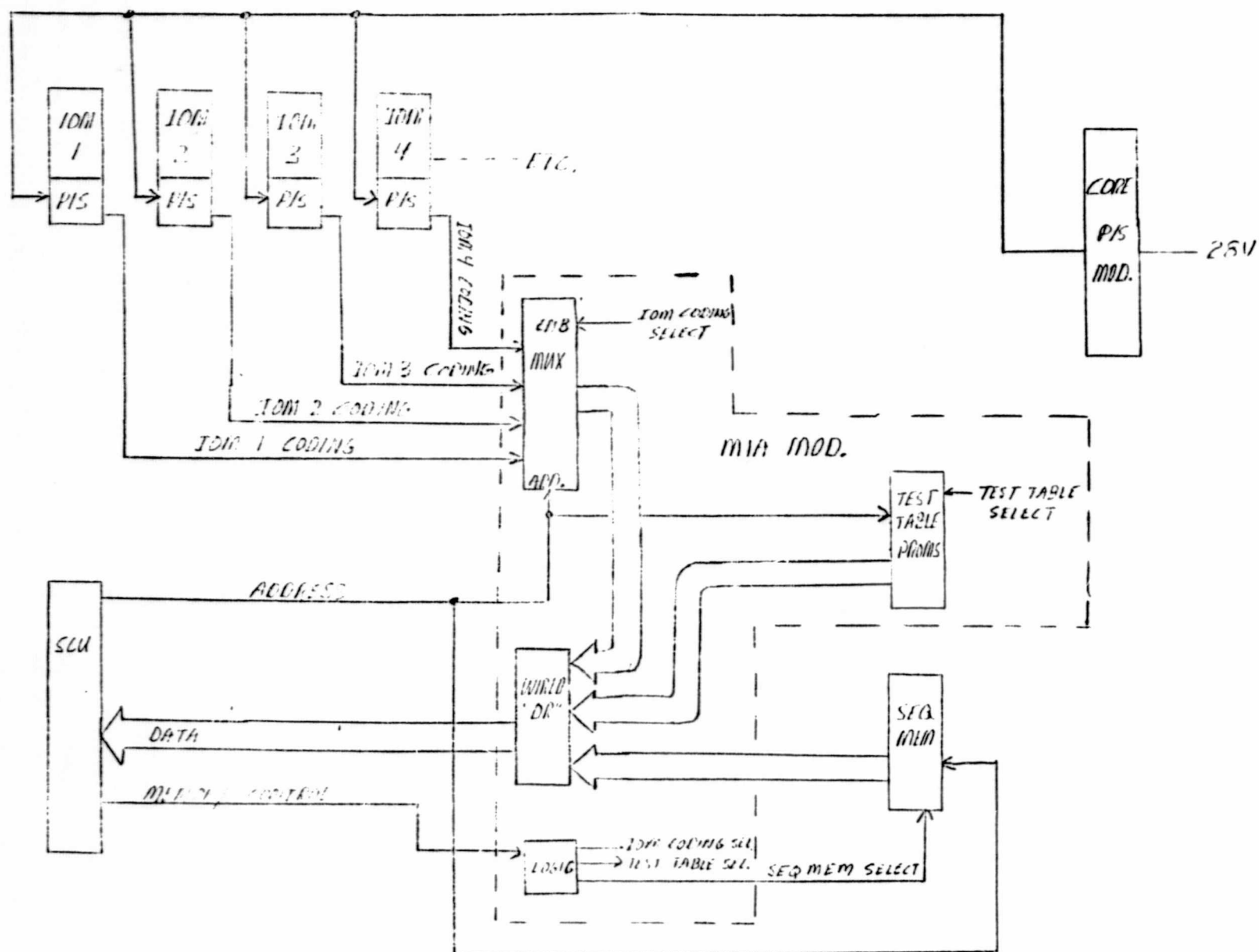
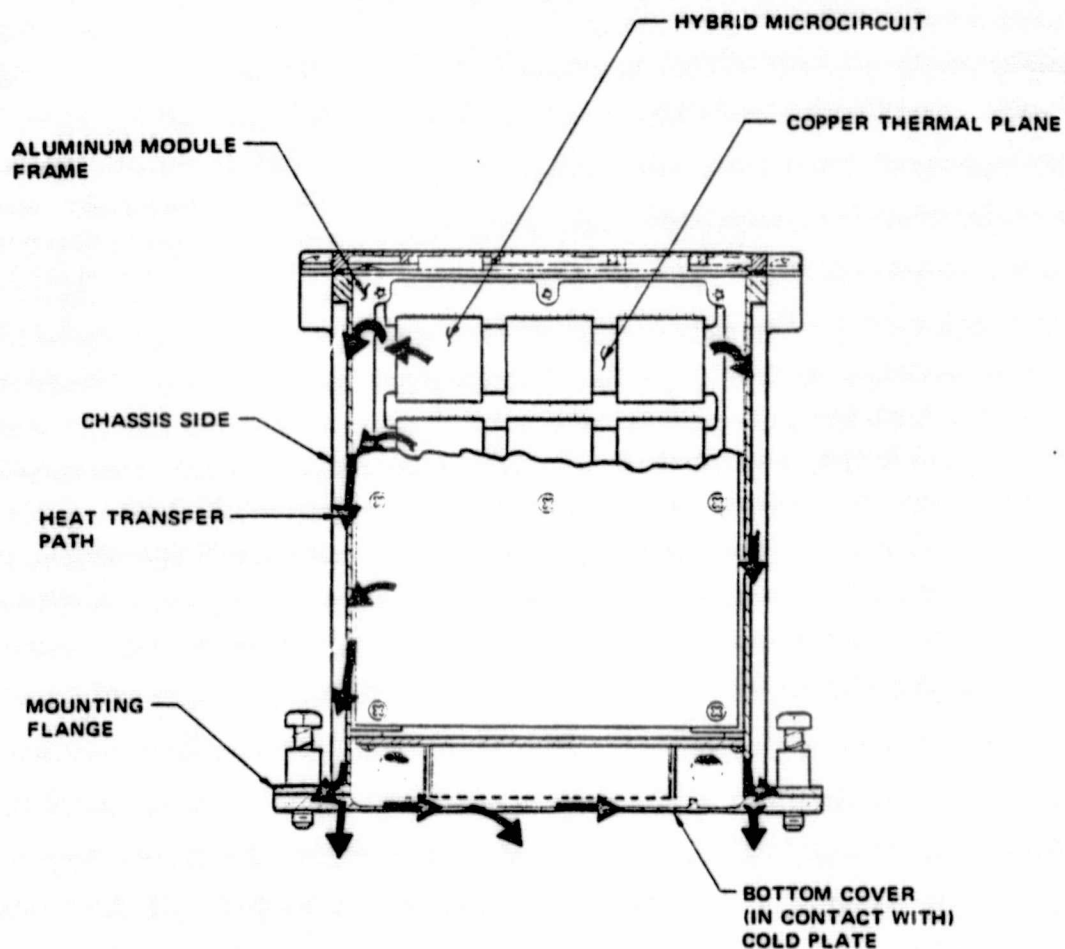


FIGURE 10
FLEXIBLE MDM ARCHITECTURE (SIMPLEX)



448-1-575

Figure 11
Single Chassis Thermal Management Plan

ORIGINAL PAGE IS
OF POOR QUALITY

In the layout of the circuit card assemblies, careful attention is given to power distribution and component location to prevent the build-up of hot spots and to produce a uniform temperature throughout.

The power supply housing is mounted directly to the rear wall of the FMDM over a large surface area, thereby creating an excellent conduction path to the chassis. Internally, component mounting bracketry and thermal planes on the printed wiring board provide short, direct conduction paths from the dissipating elements to the power supply housing.

Sperry has developed computer programs capable of analyzing thermal characteristics of electronic equipment for a variety of operating conditions and environments. These have been used in both the steady-state and transient modes to define junction temperatures and optimize the thermal design.

The results of extensive thermal analyses and tests on the Flexible MDM have shown that every semiconductor junction temperature is below 125°C as required by NASA Orbiter MDM. Moreover, for the cold plated version of the Flexible MDM all junction temperatures are below 100°C.

The thermal design of the Orbiter MDM is identical to the cold plate FMDM. Its thermal design for cold plated equipment has been qualified for cold plate cycling between 30°F and 125°F. For the same cold plate temperature the lower powered FMDM will achieve highly reliable operation with junction temperatures well below 100°C.

2. Fabrication

A. Chassis Fabrication

The Flexible MDM (Figure 12) consists of a chassis, wire-wrap motherboard, 12 plug-in modules and a power supply. Interface connectors, pressure relief

FOUR FOOT FRAME

NOTES:

1. DENOTES APPROXIMATE CENTER OF GRAVITY.
2. REFERENCE DIMENSIONS FOR INFORMATION ONLY.
3. DIMENSIONS IN [] ARE IN MILLIMETERS.
4. REMOVE PROTECTIVE COVER PRIOR TO INSTALLATION RO WEIGHT MEASUREMENTS.
5. WITH THE PROTECTIVE COVER REMOVED AND ALL FASTENERS INSTALLED, THE BOTTOM COVER SHALL HAVE A FLATNESS OF .010 AND A 63 $\sqrt$ SURFACE FINISH.
6. FLATNESS MEASUREMENT SHALL BE MADE WITH THE UNIT MOUNTED TO A SUITABLE PLATE, FLAT WITHIN .002 AFTER UNIT ASSEMBLY. FASTENER TORQUE SHALL BE 40 TO 60 INCH POUNDS. A TOTAL OF 10 POSITIONS SHALL BE INSPECTED ON APPROXIMATELY 3 INCH GRID BY MEANS OF SUITABLE ACCESS HOLES IN PLATE.
7. APPROXIMATE UNIT WEIGHT TBD POUNDS.
8. APPROXIMATE POWER DISSIPATION RANGE TBD.
9. UNIT IS DESIGNED FOR COLD-PLATE CONDUCTION COOLING THROUGH IT'S MOUNTING SURFACE.
10. CHASSIS STRUCTURAL AND THERMAL DESIGN INTEGRITY IS ESTABLISHED WHEN THE UNIT IS FULLY POPULATED WITH 12 MODULES AND THE POWER SUPPLY.

CONNECTORS		
REF DES	NASA PART NO.	FUNCTION
J1	NLSOE24-35P	SIGNAL
J2	NLSOE24-35PA	SIGNAL
J3	NLSOE24-35SC	SIGNAL
J4	NLSOE24-35SB	SIGNAL
J5	NLSOE16-35P	DATA BUS
J6	NBGH14-05FN	POWER

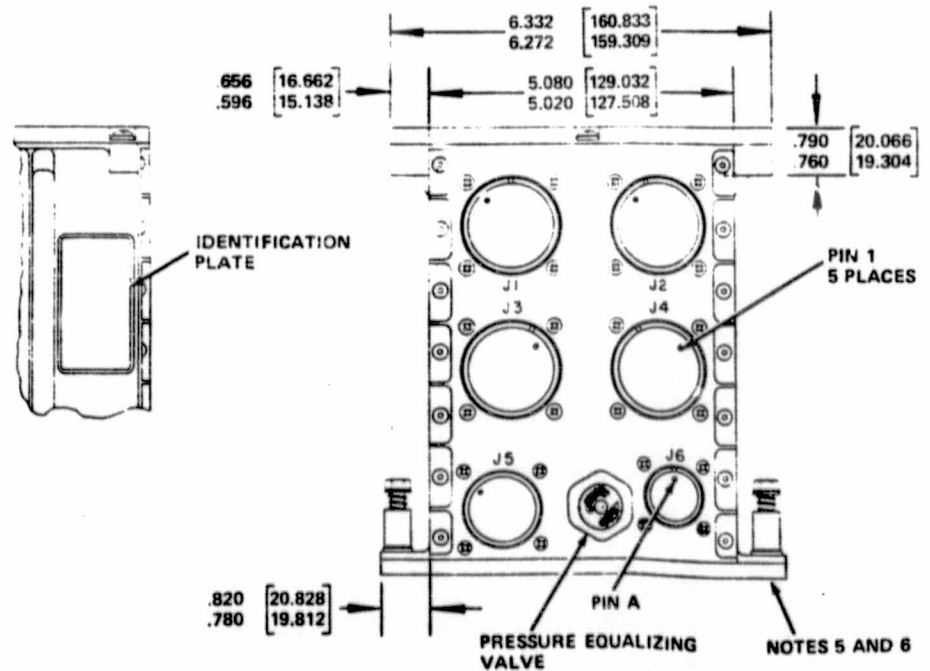


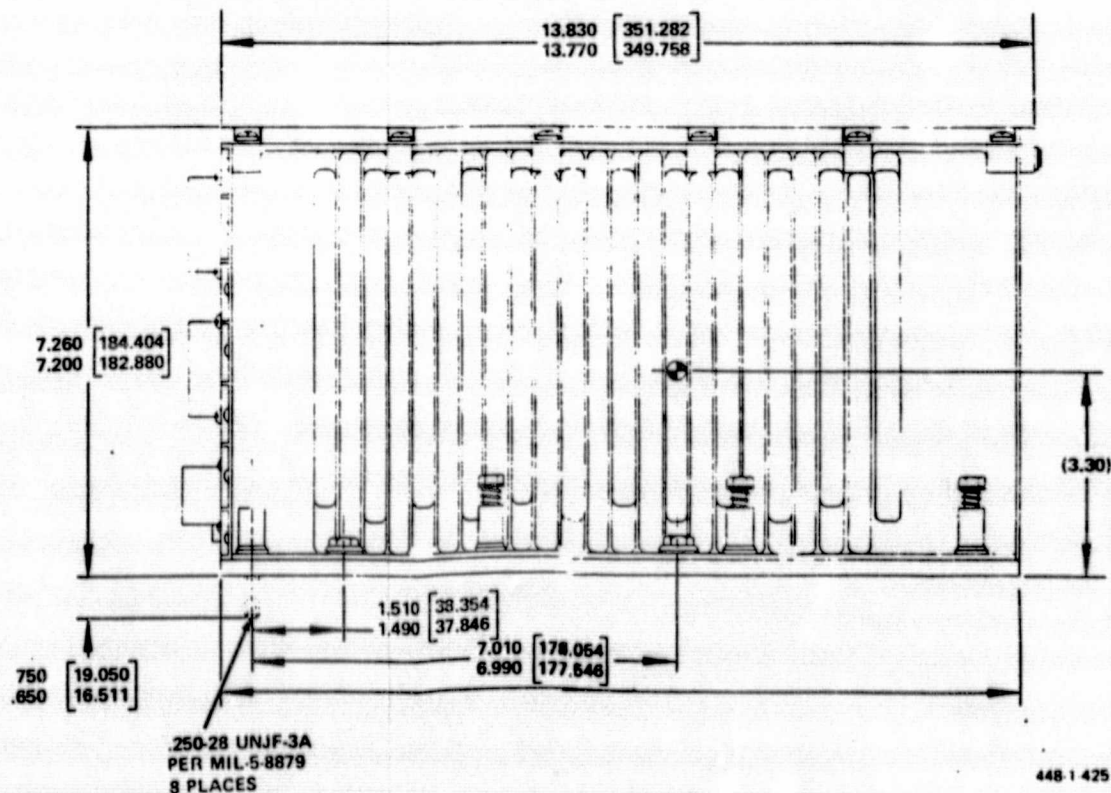
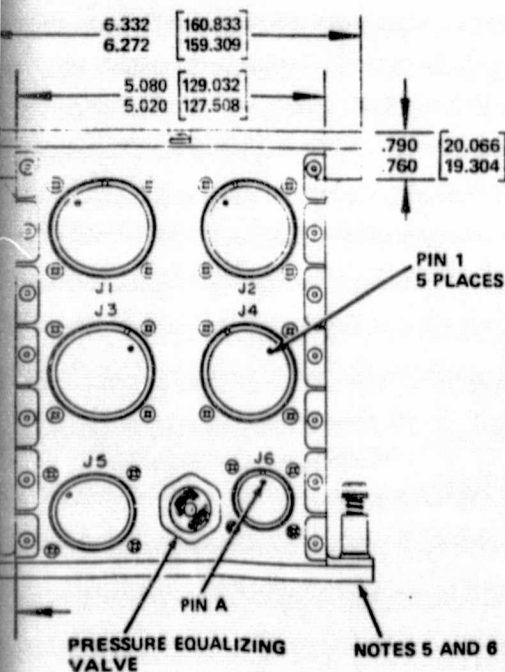
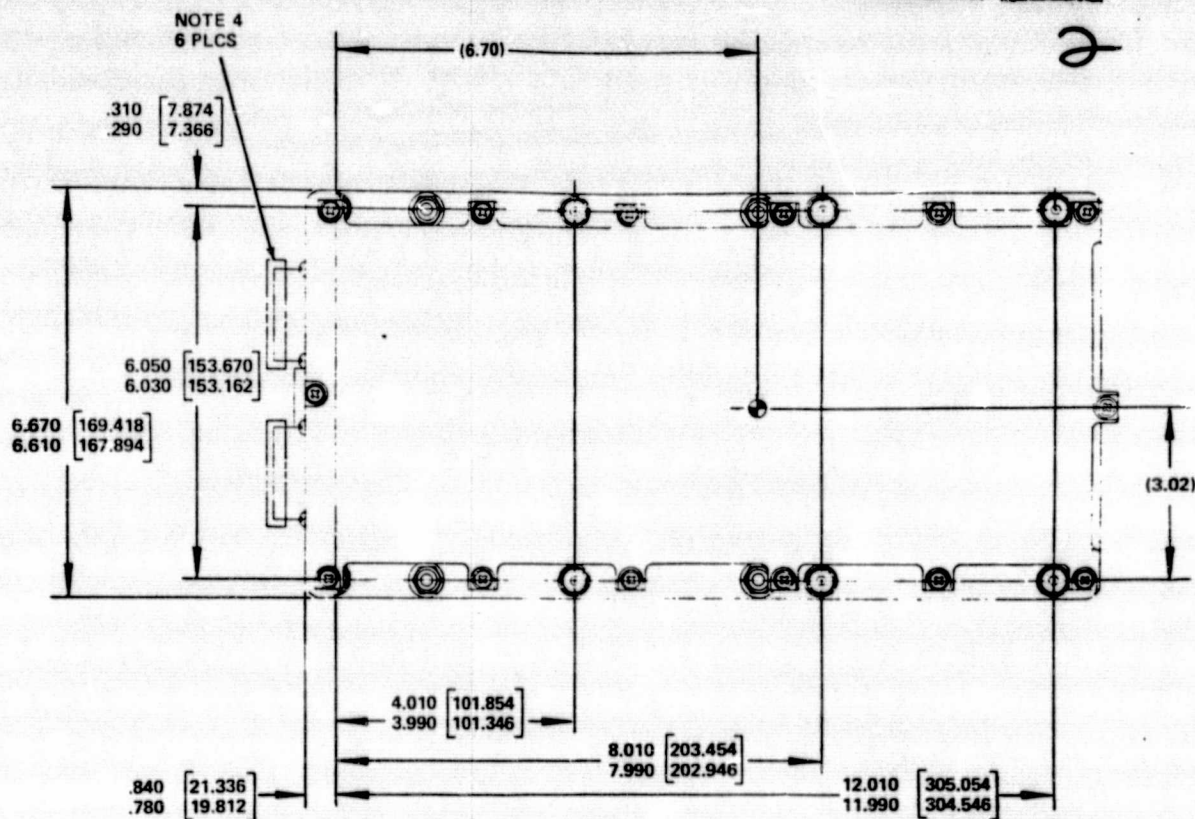
Figure 12. Single
Drawing

GRAVITY.
ATION ONLY.
S.
D INSTALLATION RO WEIGHT MEASUREMENTS.
ED AND ALL FASTENERS INSTALLED, THE BOTTOM
10 AND A 63 SURFACE FINISH.
ADE WITH THE UNIT MOUNTED TO A SUITABLE PLATE,
LY. FASTENER TORQUE SHALL BE 40 TO 60
NS SHALL BE INSPECTED ON APPROXIMATELY
ACCESS HOLES IN PLATE.

IDS.
NGE TBD.
DUCTION COOLING

DESIGN INTEGRITY IS ESTABLISHED WHEN THE
DDULES AND THE POWER SUPPLY.

CONNECTORS	
SA PART NO.	FUNCTION
SOE24-35P	SIGNAL
SOE24-35PA	SIGNAL
SOE24-35SC	SIGNAL
SOE24-35SB	SIGNAL
SOE16-35P	DATA BUS
GH14-05FN	POWER



448-1-425

Figure 12. Single FMDM Outline Drawing

ORIGINAL PAGE IS
OF POOR QUALITY

valve and nomenclature are all mounted on the front panel of the unit. Four captive mounting fasteners are attached to each side wall/bottom cover flange.

The machined side panels incorporate tight tolerance module slots to achieve a high thermal contact interface with the module frame. The side panel shape minimizes weight while achieving high strength and a good thermal conduction path to the cover.

The covers complete the chassis assembly. Both covers are of ribbed machined aluminum construction and feature captive fasteners.

The interconnect wiring system is composed of a motherboard, unit connectors, power supply connector and a wire harness. The motherboard is a Printed Wiring Board (PWB) that distributes internal voltage, ground and selected digital signals. The connectors are square wire-wrap terminal posts on which a modified wrap termination in accordance with MIL-STD-1130 and NAS 2695 is used to enhance the vibration reliability of input/output and card-to-card interconnections. Kapton-insulated wire conforming to MIL-W-81381 is used throughout the harness assembly. The entire interconnect wireharness assembly is preassembled, tested, then installed into the bottom of the chassis with self-locking hardware.

Connector J5 was enlarged to a 55-pin socket in order that it would be able to accept 27 additional wires required for in-the-unit EPROM programming. This is in addition to its function as the Orbiter data bus connector. The pin/function list for this J5 connector is shown in Table II. Note that, when tied to the data bus and not in the program mode, pin pairs 23-24, 30-31, 45-46, 54-55 and 3-16 should be shorted together within the data bus connector. In the programming mode, the +12V, +5V, -5V, PROGRAM and CLASS GEN IN (the second pin denoted in each above pair) are provided by the sequence memory

programmer and are not connected to any internal FMDM circuitry other than the sequence memory. SEQ ADR and DATA I/O bits are also provided by the programmer but are tied in common with SCU address and data circuitry.

TABLE II
CONNECTOR J5 PIN/FUNCTION LIST

Pin	1	Logic "1"
	2	Spare
	3	Logic "0"
	4	Spare
	5	Bit 1 (MSB)
	6	Bit 2
	7	Bit 3
	8	Bit 4
	9	Bit 5 (LSB)
	10	Spare
	11	Data Bus (HI)
	12	Data Bus (LO)
	13	Spare
	14	Spare
	15	Spare
	16	Program
	17	SEQ ADR CSL
	18	SEQ ADR 8
	19	SEQ ADR 7
	20	SEQ ADR 6
	21	SEQ ADR 5
	22	Spare
	23	CLASS GEN OUT
	24	CLASS GEN IN
	25	SEQ ADR 4
	26	SEQ ADR 3
	27	SEQ ADR 2
	28	SEQ ADR 1
	29	SEQ ADR 0
	30	+5V Out
	31	+5V In
	32	Data I/O 0
	33	Data I/O 1
	34	Data I/O 2
	35	Data I/O 3

Table II (con't)

Pin 36	Spare
37	Spare
38	Spare
39	Spare
40	DATA I/O 4
41	DATA I/O 5
42	DATA I/O 6
43	DATA I/O 7
44	Spare
45	-5V Out
46	-5V In
47	Spare
48	Spare
49	Spare
50	Spare
51	Spare
52	Spare
53	Spare
54	+12V Out
55	+12V In

Note: Shield tied to connector backshell.

Chassis - The chassis and covers are precision machined from aluminum alloy, then machined after riveting in an assembly fixture to locate the cover fastener fittings, the cover mounting surfaces and motherboard mounting surface.

Quality control procedures, starting with material certification of the raw stock and following on through dimensional inspection to visual inspection of the completed chassis, are inserted at appropriate points in the fabrication and assembly process. All inspection operations are under the formal control of the Sperry Quality Control department.

Finishes are applied at appropriate points in the fabrication cycle. For example, the sides containing the card guides are anodized prior to assembly. Faying surfaces between parts are masked to prevent anodization and then cleaned prior to assembly to assure electrical continuity. After machining, the entire chassis is given a chemical-film treatment per MIL-C-5541.

Printed Wiring Boards - Another of the major fabricated items are the printed wiring boards. The boards are of conventional glass-epoxy construction using standard fabrication procedures. Board construction techniques and materials meet the design requirements of MIL-P-55640.

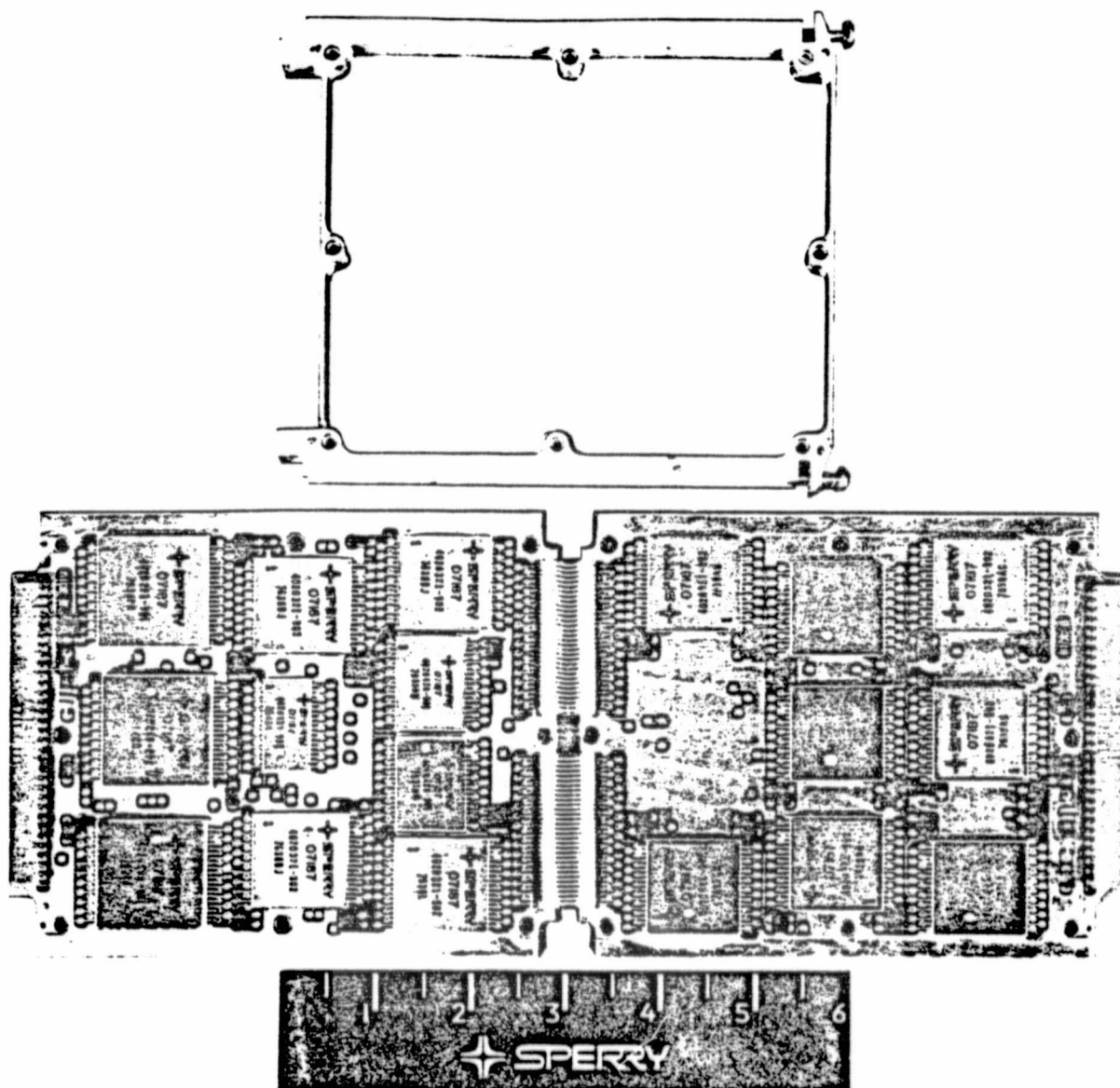
Motherboard - Fabrication of the multilayer motherboard is the same as the CCA boards. Wire-wrap pins are then installed in the plated holes. This technique is currently in production at Sperry on Space Shuttle hardware.

Circuit Card Assemblies and Power Supply - The design of the CCAs and power supply is identical to equipment currently in production at Sperry. All producibility problems have been worked out; people have been trained to assemble this same type of hardware.

B. Module Fabrication

General Features - High component density, design flexibility, efficient thermal management and structural rigidity are features of the module design concept developed for the Orbiter MDM and SRB MDM as shown in Figure 13. For the Flexible MDM, the module design is identical except for a small increase in height.

- o Each module assembly consists of two Printed Wiring Boards (PWB), an aluminum frame, captive mounting hardware, card connectors and individual components.
- o The PWB is a multilayer board containing all circuit lines on internal layers and is fabricated from flame retardant glass epoxy material conforming to MIL-P-55617. Construction techniques and materials conform to MIL-P-55640. Surface layers are restricted to pads with the exception of the etched copper thermal plane. The copper plane provides a direct thermal conduction path from the



448-1-500

Figure 13
Circuit Card Modules Assembly

ORIGINAL PAGE IS
OF POOR QUALITY

components to the aluminum frame. The assembled PWB is conformally coated with Dow Corning 3140 for moisture protection.

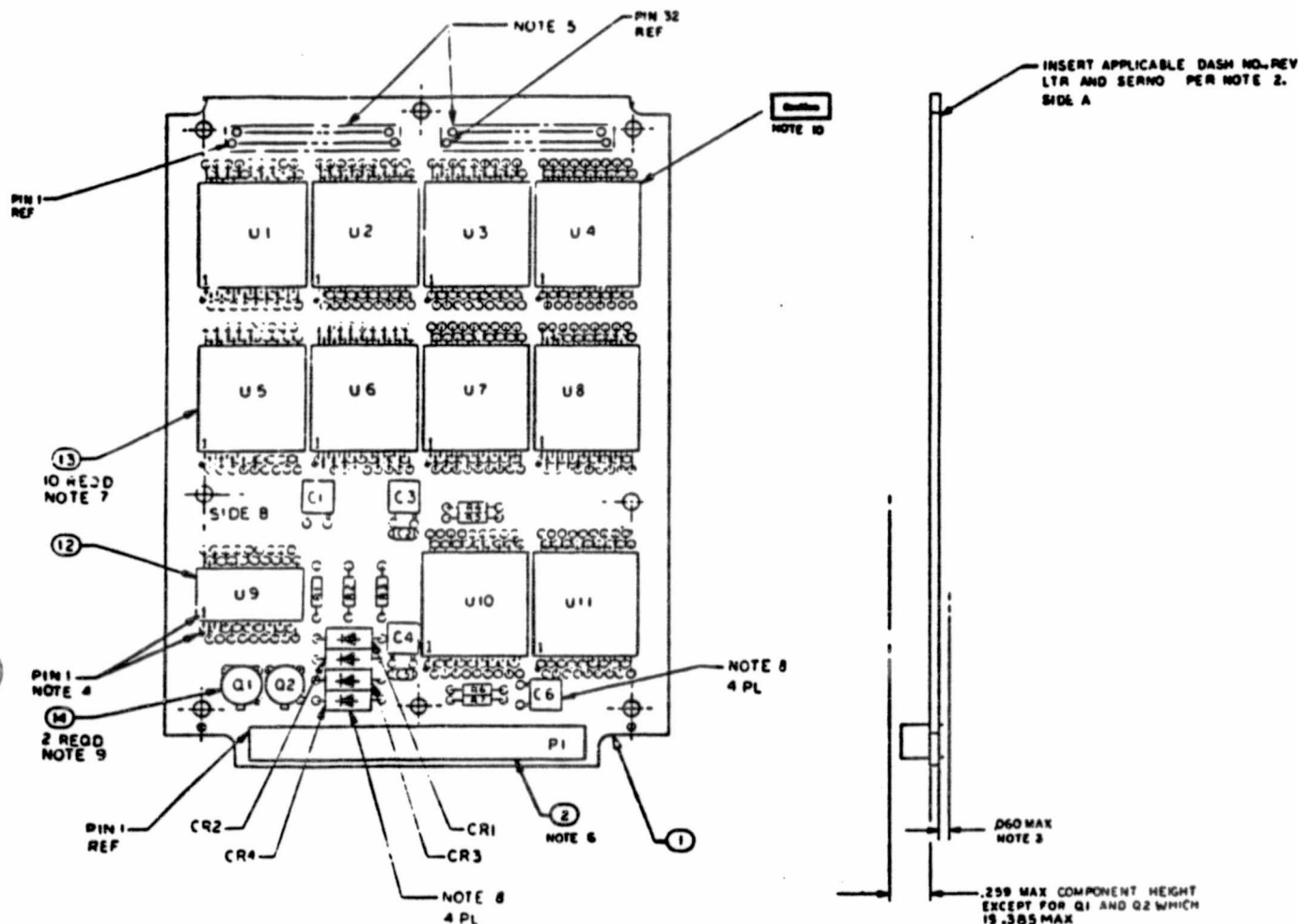
- o The number of connector contacts is minimized in the module by employing flexible printed wiring for the interconnection between module PWBs.
- o Board assembly connectors are of the box contact type which mate with .025 inch square wire-wrap posts on .100 inch centers. The connector series is available from a number of manufacturers and has an exceptional record in a wide variety of applications.

Pulse Output 28-Volt (P028) - The P028 was laid out and fabricated in a manner very similar to the Discrete Output 28-Volt (D028) module as shown in Figures 14 and 15. Maximum use was made of hybrids from the D028 module, including the D028 control 1 (A2U1), BUS RCVR (A2U8), BUS CONTROL (A2U9), D028 P/S (A1U9) and P/S Mod 3 (A1U10) hybrids. Modified hybrids include all D028 DRIVER 2 types (A1U1-8, 11; A2U3-5) and D028 CONTROL 3A (A2U2).

Sequence Memory (SEM) - The sequence memory is fabricated on the A2 side of a standard 62-pin module as shown in Figure 16 and is always plugged into slot 11 (counting from 0) in the FMDM chassis. The entire circuit is left exposed in order that the module can be removed and its M2708 EPROM erased by the UV eraser unit.

During conformal coating, the EPROM window is masked in order to avoid being covered by the UV-opaque coating.

Power Supply (P/S) - The Flexible MDM core power supply is a replaceable subassembly located at the rear of the chassis.



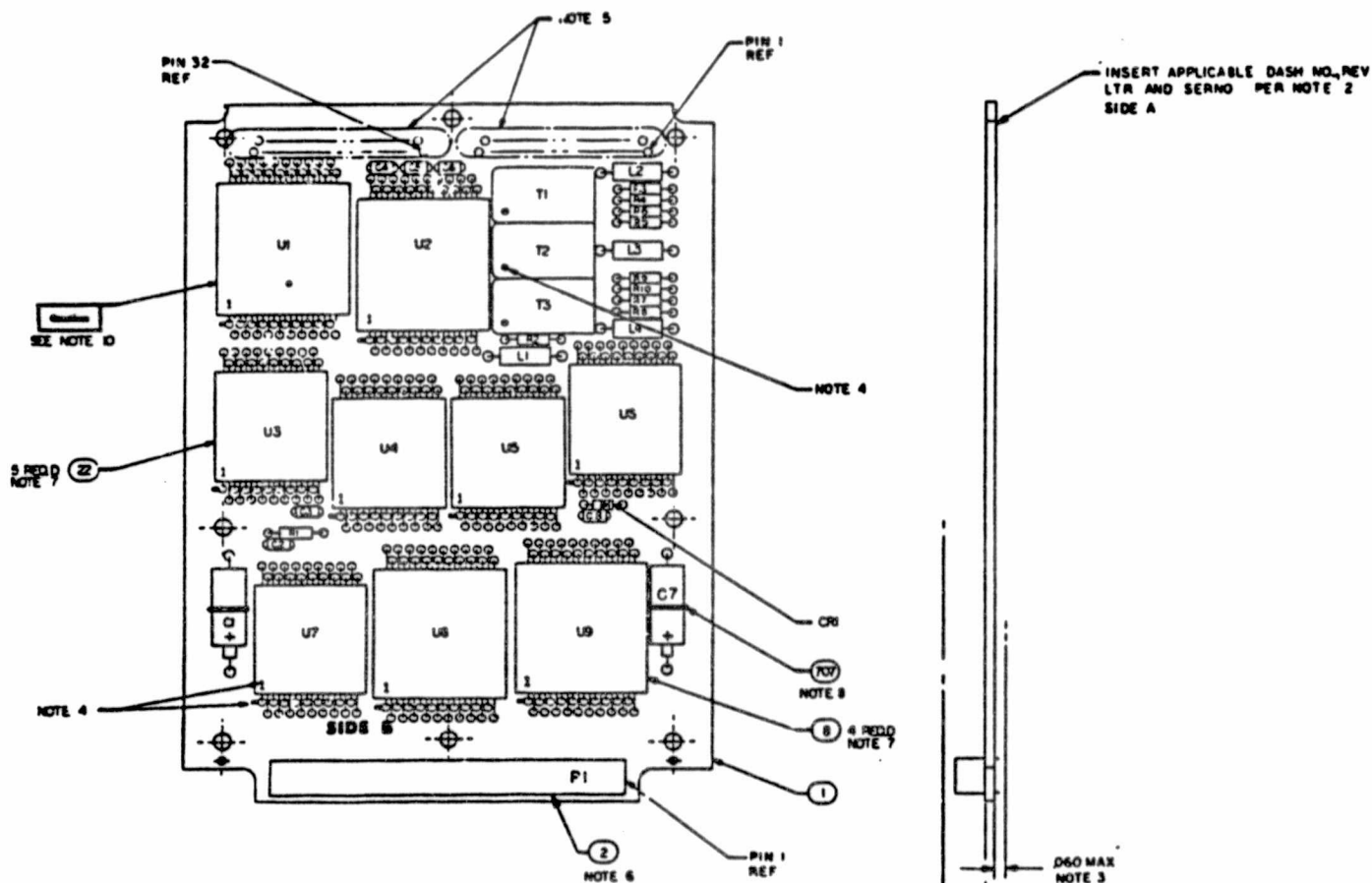
NOTES:

1. COMPONENT DESIGNATIONS ARE FOR REFERENCE ONLY.
2. MARK .095.03 HIGH CHARACTERS PER ITEM 702 METHOD 4, USING .015 TOL AND 704. WITH LIMITATIONS DO NOT APPLY.
3. C. IF APPROXIMATELY AS SHOWN.
4. LEADS ON CIRCUIT SIDE A SHALL HAVE A MAXIMUM PROTRUSION AS SHOWN FROM BASE LAMINATE. THE MINIMUM REQUIREMENT IS THAT THE LEAD BE DISCERNIBLE IN THE SOLDER CONNECTION. EXPOSED COPPER PERMISSIBLE ON TRIMMED LEADS.
5. P HOLES ON COMPONENTS AND TAB ON CIRCUITRY INDICATE PIN 1.
6. HOLES LOCATED IN AREAS SHOWN SHALL NOT BE SOLDER FILLED.
7. ITEM 2 SHALL BE MOUNTED FLUSH TO ITEM 1 WITH CONTACT OPENING DOWN.
8. APPLY ITEM 13 UNDER U1, U2, U3, U4, U5, U6, U7, U8, U10, AND U11, AND ITEM 12 UNDER U9. C. IF PER ITEM 702. A PERMISSIBLE VARIATION IS: BOND U1 THRU U11 TO ITEM 1 PER ITEM 705. ADHESIVE FILLET SHALL BE VISIBLE ALL AROUND COMPONENTS, BUT NOT ON SOLDER PADS.
9. BOND COMPONENTS C1, C3, C4, C5, AND C6 THRU CR4, TO ITEM 1 PER ITEM 705. EXPOSED ADHESIVE PERMISSIBLE.
10. BOND ITEM 14 TO ITEM 1, Q1 AND Q2 PER ITEM 705. EXPOSED ADHESIVE PERMISSIBLE.
11. THE FOLLOWING DEVICES ARE SUBJECT TO DAMAGE BY ELECTROSTATIC CHARGES: U1 THRU U11.
12. ASSEMBLE PER ITEM 701.
13. ADD CONDUCTOR WIRES 601 AND 602 ON SIDE A, SEE "TERMINATION TABLE."
14. BOND JUMPER WIRES USING ITEM 705 PER ITEM 701.

TERMINATION TABLE				
COND NO.	ITEM NO.	COLOR	FROM CIRCUIT POINT	TO CIRCUIT POINT
601	707		P1-33	P1-43
602	707		P1-32	P1-42

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE 14
CIRCUIT CARD ASSEMBLY AI-PULSE OUTPUT 28-VOLT
(FROM DRWG. NO. 4033998-901)
- 29 -



NOTES:

1. COMPONENT DESIGNATIONS ARE FOR REFERENCE ONLY.
2. MARK .09 ±.03 HIGH CHARACTERS PER ITEM 702 METHOD N, USING ITEM 703 AND 704. LOCATE APPROXIMATELY AS SHOWN.
3. LEADS ON CIRCUIT SIDE "A" SHALL HAVE A MAXIMUM PROTRUSION AS SHOWN FROM BASE LAMINATE. THE MINIMUM REQUIREMENT IS THAT THE LEAD BE DISCERNIBLE IN THE SOLDER CONNECTION. EXPOSED COPPER PERMISSIBLE ON TRIMMED LEADS.
4. DOT ON "T" ON COMPONENTS AND TAB ON CIRCUITRY INDICATES PIN 1.
5. "S" LOCATED IN AREAS SHOWN SHALL NOT BE SOLDER FILLED.
6. ITEM 1 SHALL BE MOUNTED FLUSH TO THE HIGHEST POINT OF ITEM 1 WITH CONTACT OPENING DOWN.
7. APPLY ITEM 8 UNDER U1, U2, U6, AND U9. APPLY ITEM 22 UNDER U3 THRU U7; CURE PER ITEM 706. A PERMISSIBLE VARIATION: BOND U1 THRU U9 TO ITEM 1 PER ITEM 705. AN ADHESIVE FILLET SHALL BE VISIBLE ALL AROUND COMPONENTS, BUT NOT ON SOLDER PADS.
8. SECURE C1 AND C7 TO ITEM 1 USING ITEM 707.
9. ASSEMBLE PER ITEM 704.
10. THE FOLLOWING DEVICES ARE SUBJECT TO DAMAGE BY ELECTROSTATIC CHARGES: U1 THRU U9.

FIGURE 15

CIRCUIT CARD ASSEMBLY A2-PULSE OUTPUT 28-VOLT
(FROM DRWG. NO. 4034026-901)

Careful consideration was given to power supply housing design and component placement to obtain an efficient package density, structural integrity, effective thermal management, and EMI isolation.

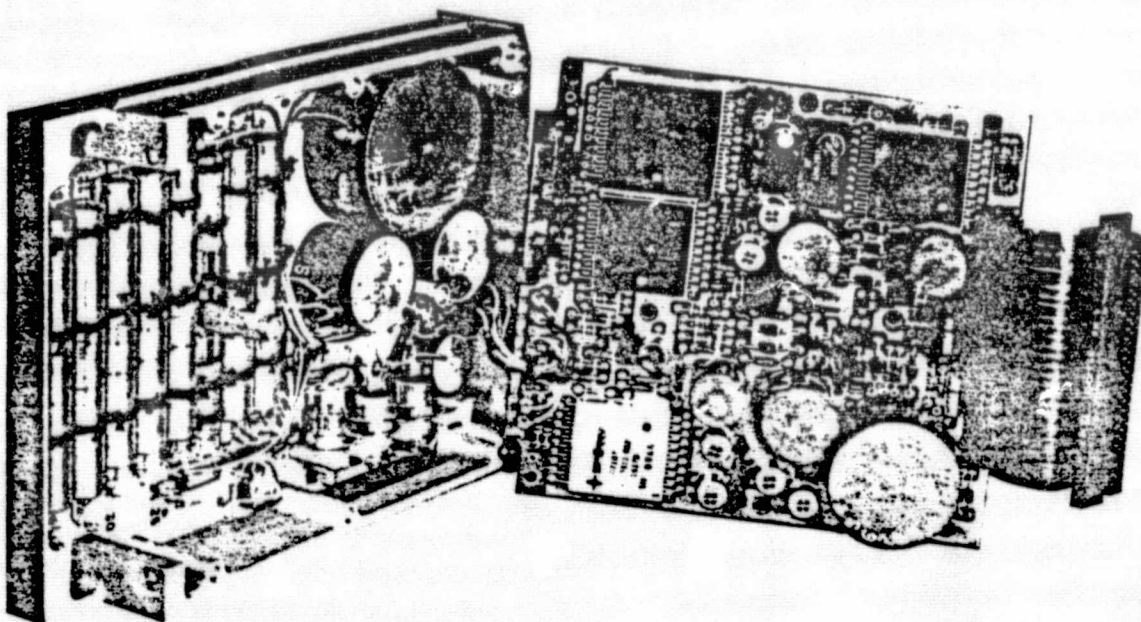
Construction consists of a machined aluminum housing and one Printed Wiring Board. Internally, components are mounted to the aluminum housing or on the PWB thermal plane as shown in Figure 17. A small wiring harness using polyimide-insulated wire provides the necessary interconnection. The power supply is mounted directly to the rear wall of the chassis. A large contact area is provided in the chassis to enhance both structural and thermal characteristics. High power dissipating components mount directly to the power supply housing. A PWB supports lower power components to reduce volume and weight of wiring.

A power supply connector conforming to MIL-C-24308 is used because of its high current carrying capability and excellent reliability history in military airborne applications.

C. Hybrid Circuits

Hybrid circuits are extensively used in the FMDM to reduce size and weight and to improve reliability. The hybrid circuit is generally a functional block embodying the equivalent of approximately 10 to 100 discrete components.

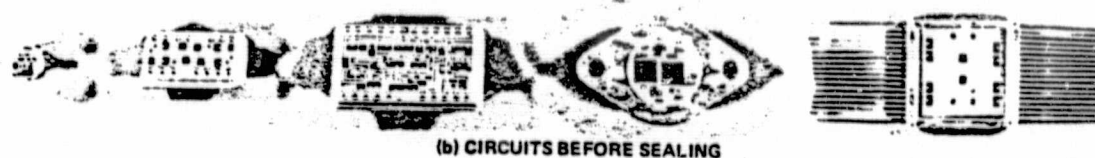
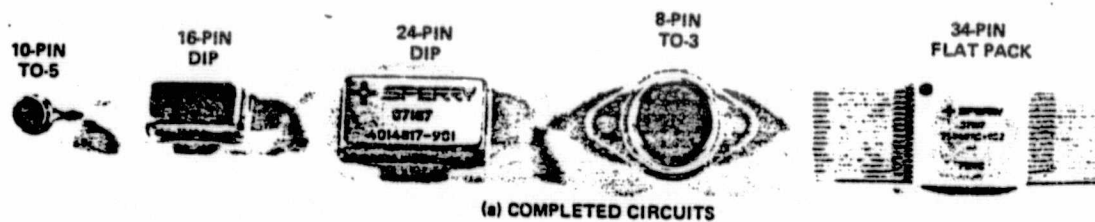
The printed-and-fired or thick-film process is used in Sperry-designed hybrid circuits. This type of circuit, typical examples of which are shown in Figure 18, has been in service in Sperry equipment for several years. Hybrid circuits fabricated at Sperry are housed in a variety of packages to suit the end item application. The packages shown are typical of current production. The flat-pack predominates in the FMDM (Figure 19).



448-1-525

Figure 17
Power Supply Assembly

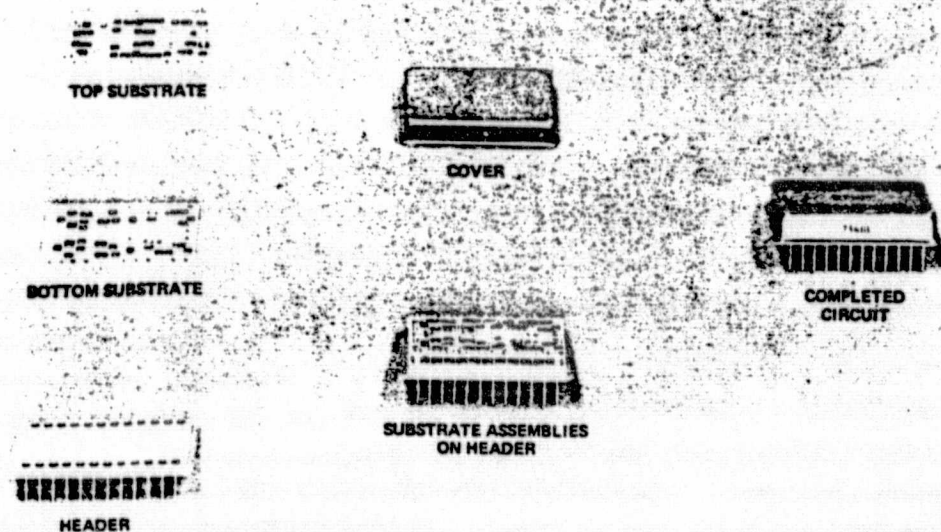
ORIGINAL PAGE IS
OF POOR QUALITY



448-1-550

Figure 18
Typical Hybrid Circuits

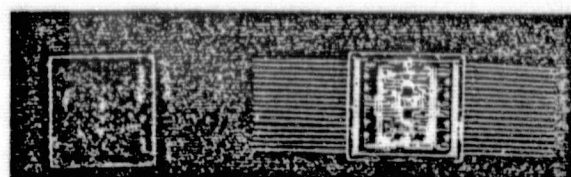
ORIGINAL PAGE IS
OF POOR QUALITY



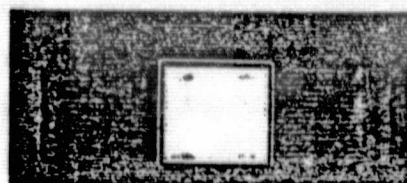
44B-1-551



COMPLETED CIRCUIT



SUBSTRATE IN HEADER



SUBSTRATE HEADER

44B-1-551

Figure 19
Hybrid Circuit Assembly Details

Briefly, the hybridization process involves the forming of resistive and conductive patterns on ceramic substrates. For instance, platinum-group metals form the basis for resistors and platinum-gold and pure gold form the interconnections. The appropriate patterns are printed on the alumina substrate, then dried and fired at a temperature of approximately 850°C to cure the pattern and fuse it to the substrate. Conductive patterns of high circuit density or complexity can be achieved by multiple-layering techniques in which alternate layers of conductor and dielectric materials are printed with appropriate electrical connections between conductor layers. Resistors are given a stabilization aging and are then trimmed to their required value with a computer-controlled laser system.

All capacitors and semiconductor dice such as integrated circuits, transistors and diodes are added to the resistor-interconnect pattern as individual chip components. Semiconductor devices are generally purchased and mounted in conventional chip form and gold wires are added for interconnections to the conductive patterns. FMDM hybrids involve digital integrated circuits such as TTL and CMOS; analog devices such as operational amplifiers and JFET, MOSFET, and most types of bipolar transistors.

- o Resistor ratios of ± 0.5 percent can be trimmed on the same substrate.
- o Resistors can be adjusted (trimmed) with the circuit operating (dynamic trimming) to achieve specific characteristics such as gains, offsets, nulls, etc. Typical gain tolerances are .5 percent; amplifier offsets and nulls are ± 2 millivolts.

ORIGINAL PAGE IS
OF POOR QUALITY

Electrical testing of the circuits is done on automatic test equipment. The tester is programmed for the test conditions and test limits of each circuit type. When the tests are completed, a "pass" or "fail" signal is given. If the "fail" signal is given, the tester identifies the tests that were failed.

All of the hybrid circuits designed for the FMDM program were fabricated in the Sperry microcircuit facility. All hybrid circuits produced in the Sperry facility are inspected and screened to the quality requirements of MIL-STD-883, Method 5004.1, Level B with the following exceptions or additions:

Internal Visual - MIL-STD-883, Method 2017, Condition B as a minimum with additional requirements for prevention of loose particles.

PIND Test - is added.

Constant Acceleration - The test condition is determined by package size and capacitor sizes.

Burn-In - All circuits are burned-in for 168 hours under operating conditions at a temperature that will cause the maximum junction temperature to be between 125°C and 150°C.

Two package types are used by Sperry for hybrid circuits, the first being a header with pins out the bottom of the package and the second, a flat pack in which the leads come out the side of the package. Different sizes, pin counts, and shapes are available for both package types. The type and size of package selected for a circuit is a function of the circuit, pin count requirements, power dissipation and mounting technique used at the next higher assembly.

For the header-type package the completed substrates are attached to the pins of the header by soldering in an inert atmosphere. When the flat pack is used, the completed substrate is mounted in the cavity of the package and gold wires are added to connect the circuit on the substrate to the leads of the package. After thorough cleaning, both package types are then hermetically sealed with a metal cover (welding being employed in all FMDM hybrids) in a dry nitrogen atmosphere and protected from the rigors of the equipment environment by a hermetically sealed package. An example of a typical circuit assembly was shown in Figure 19. The circuit shown consists of the two multi-layer substrates with 93 components including 37 semiconductors, three capacitors and 53 resistors.

The basic accuracy of a hybrid circuit lies in the fabrication of the thick-film resistors. Although tighter specifications can be met by special processing, typical thick-film resistors have a Temperature Coefficient of Resistance (TCR) of less than 100 ppm/°C and tolerances as low as one percent of absolute value. However, the hybrid fabrication process provides several techniques for obtaining better accuracy from the circuits. These are:

- o All components within the hybrid will be at approximately the same temperature during operation. This provides uniform tracking of all components.
- o Resistors manufactured in one printing operation are all made from the same paste and thus will have essentially identical TCRs. These resistors will track to within 20 ppm/°C.

D. Sequence Memory Programmer

The FMDM Sequence Memory Programmer is capable of programming the FMDM sequence memory EPROM. The unit is self-contained, lightweight (38 pounds) and portable. It connects to the sequence memory module for

programming via front panel connector J5. A self-test feature also allows the programming of a test EPROM, mounted in a programmer front panel ZIF socket, to be carried out prior to actual sequence memory programming.

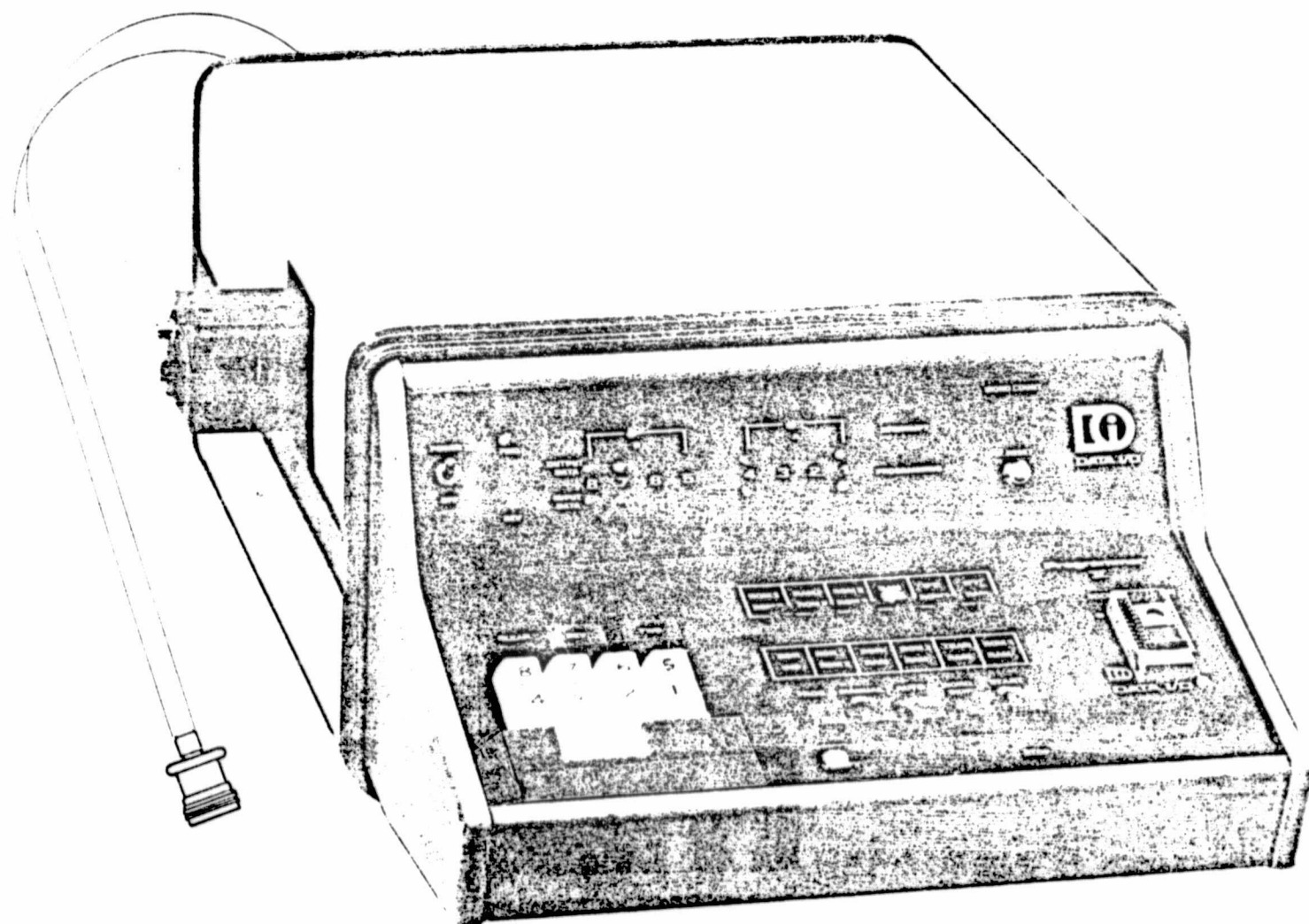
The Sequence Memory Programmer (Figure 20) is a modified DATA I/O Model V Programmer. It has a 1024 x 8-bit RAM memory and an integral paper tape reader. All operator controls are located on the front panel (Figure 21) of which the following are utilized during sequence memory programming:

- o RDR IND: Selection of this mode allows the paper tape to automatically index up to the beginning of sequence memory data.
- o RDR RAM: This mode loads the paper tape into programmer RAM.
- o RAM ROM 2: This mode initiates the 4 1/2 minute programming cycle for either the test EPROM or the FMDM sequence memory.
- o RDR ROM 2: This mode is used as a final verification of programming, and compares the paper tape directly to the contents of the programmed memory.

Indicator lights are used to show programmed (LED on) and unprogrammed locations (LED off). The top row of lights show old data in the device being programmed; the bottom row indicates new data for input to the programmed device.

A protective carrying case is also provided for the programmer.

In operation, it was found that the M2708 EPROM's are sensitive to, and can be partially erased by, prolonged exposure to fluorescent lights which have a high -UV content. It is therefore recommended that all test EPROM's and Sequence Memory modules be stored in light protective cases if it is



ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE 20
FMDM SEQUENCE MEMORY PROGRAMMER

ROM 1	RAM	ROM 2	RAM	IPT	IPT
ROM 2	ROM 2	ROM 2	RAM	ROM 2	RAM

--	--	--	--	--	--

RDR	RDR	RDR	ROM 2	TRAN	ROM 1
INDEX	ROM 2	RAM	RAM	RAM	RAM

PROG MANUAL AUTO WORD START
 SKIP

--

VERIFY

STOP

FIGURE 21

SEQUENCE MEMORY PROGRAMMER
FRONT PANEL MODE SWITCHES

ORIGINAL PAGE IS
OF POOR QUALITY

desired to retain the memory for an extended period of time. Their sensitivity to UV light is also prevalent during the programming cycle using the cable and therefore the FMDM top cover should be in place at the time of sequence memory programming.

E. Sequence Memory UV Eraser

The sequence memory UV eraser (Part No. 4033990) is a powerful UV lamp which provides efficient erasure of both test EPROM's and the sequence memory module EPROM (See Figure 22). The unit includes a lamp and 30-minute timer assembly which operates at 110V AC. A detachable tray holds either individual test EPROM's or an entire sequence memory module during erasure.

UV intensity is 10 watt-sec/cm² which at 1 inch separation will erase an M2708 in 15 minutes although 30 minutes is recommended to ensure complete erasure. Since short wave ultraviolet light can injure eyes and skin, all enclosures are light tight.

3. Test

A. Performance Test Specification

The FMDM version of the Performance Test Specification (T4033582) was completed in November and was utilized in the ATE test demonstration carried out at the November program review. This version of the test specification was similar to the MDM test specification with primary changes being in the test procedure to allow operator definition of IOM module mix, addition of a P028 test section, modification of the DCIN section to test 32 differential channels, and the generalization of the sequence memory test procedure. The document and resultant software were written for a simplex FMDM but can accomodate a duplex box with minor additions.

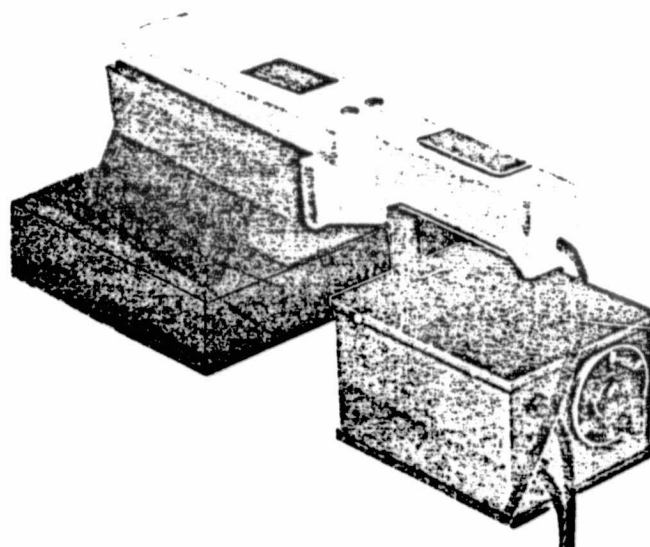


FIGURE 22
SEQUENCE MEMORY UV ERASER

ORIGINAL PAGE IS
OF POOR QUALITY.

B. Functional Demonstration

The November ATE demonstration involved the use of the new universal test software and adapter hardware. The capability to test the FMDM independent of input/output module configuration was shown, in addition to the ability to interchange IOM's in the field. The P028 breadboard was also functionally tested. A typical listing of a similar ATE sequence is shown in Appendix VII.

Verification of the sequence memory contents was also carried out during this demonstration. Prior to the ATE run, the memory was programmed with a random sequence from a pre-punched paper tape. The formatted data on this paper tape is shown in Appendix VIII. The memory contents readout on the data bus is shown in Appendix IX and agrees exactly with the programmed data. Note that the first 16_{10} locations do not agree; that is because these locations indicate IOM configuration and are hardwired to IOM pins on the motherboard. Thus, when these are read out over the data bus the basic IOM mix can be determined. Also note that the sequence memory EPROM itself need not be programmed with this IOM information since it is automatically accomplished by IOM hardwire multiplexing.

C. Acceptance Test Procedure

The Flexible MDM Acceptance Test Procedure (TP4032521) was completed as required. It was based on the Orbiter MDM Test Procedure and includes insulation/dielectric tests, BITE tests to be run during vibration and thermal tests, and retest procedures.

An acceptance test dry run was made and successfully demonstrated operation of the microcomputer software used to run BITE during environmental testing. An example of the resultant output for such a test is shown in Appendix X for the following FMDM configuration:

MODULE NO.MODULE NAME

0	DI5
1	D028
2	D028
3	DI28
4	DCIN
5	D05
6	SDI/O
7	DCO

During actual acceptance testing, all the pass data shown in the print out is normally not shown; only FAIL data would be printed if it occurs at any time. The software continually runs BITE until interrupted by an external operator input. The module mix may be changed at any time by selecting the MAP mode and requesting a CHANGE as shown at the beginning of Appendix X.

4. FMDM Thermal Study

See Appendix XI.

APPENDIX I

HYBRID ANALYSIS DATA SHEET -

D028 CONTROL 3A

HYBRID REQUEST DATA SHEET

1. Name of Circuit: DO 28 CONTROL 3A Requestor: J. L DeRuiter
Part Number: 4026159 Date: 8/19/77 Dept: 5820
Ext: 1445 Mail Station: T-2
2. Charge Number for Development and Prototypes: A.O. Number: 230662
Prod. No. _____
3. Quantity Usage:
3.1 Prototypes:
3.1.1 No. Required: 3
3.1.2 Date Required: 12/27/77
3.2 Production:
3.2.1 No. Required: 5
3.2.2 Date Required: 3/23/78
4. System Requirements:
4.1 System Operating Temperature Range: -10 °C to +71 °C
4.2 System Storage Temperature Range: -65 °C to +125 °C
4.3 Special System Requirements: _____

5. Circuit Requirements:
5.1 Case Operating Temperature Range: -20 °C to +100 °C
5.2 Circuit Schematic: (Attach separate sheet)

Analysis to 5820-HDM-0508 Rev C

5.3 Component Information (attach separate sheet)

5.3.1 Resistors:

- a) Value
- b) Tolerances
- c) Power Dissipation (worse case)
- d) Temperature Coefficient of Resistance (TCR)
- e) Voltage across resistor

5.3.2 Capacitors:

- a) Value
- b) Tolerances
- c) Working Voltage (DC)
- d) Temperature Characteristics

5.3.3 Transistors, Diodes and Integrated Circuits:

- a) Standard 1N, 2N or IC numbers
- b) Power Dissipation (worse case)

5.3.4 State any unusual electrical problems such as component proximity, sensitive lead, etc.:

5.3.5 Non-preferred Components Utilized: (Specify non-preferred/single source components used; i.e., Device and Source).

5.4 Circuit Power Dissipation:

5.4.1 37.67 m watts (average)

5.4.2 84.196 m watts (worse case)

5.5 Has the circuit been worst-case analyzed for variation in component characteristics?

yes

no

6. Circuit Testing:

6.1 Has the circuit been tested over the circuit operating operating temperature range (para. 5.1) for worst-case variation in component characteristics?

yes

no

6.2 Did the circuit meet all requirements in the above temperature testing?

yes

no

6.3 Test Specification (attach separate sheets)

7. This circuit has been reviewed by hybrid engineering for technical feasibility.

approved

disapproved

Hybrid Engineer:

John A. Smith

Date:

8/25/77

Section Head:

A. D. Lawson

Date:

26 Aug 77

Comments:

8. Engineering approval:

A. McDonald

8/29/77

Section Head:

J. White

Date:

29 Aug 77

Department Head:

Date:

Manager:

Date:

World Component Information

Engineer John Kravetz

Extension X1917

Circuit

Name DO 28 CONTROL 3A

P/N 4026159

Date 8/19/77

Prelim Ref. Design	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
U1				1.6mw		10v	CD4013			
U2				1.6mw		10v	CD4013			
U3				0.46mw		10v	CD4011			
U4				1.36mw		10v	CD4023			
U5				2.2mw		10v	CD4027			
U6				4.9mw		10v	CD4049			
U7				0.16mw		10v	CD4001			
U8				6mw		10v	CD4047			
U9				6mw		10v	CD4047			
U10				6mw		10v	CD4047			

ORIGINAL PAGE IS
OF POOR QUALITY

Extension X1417

Circuit Name: DO 28 CONTROL 3A

P/N 4026159

Date 8/19/77

[illegible]

[illegible]

Prelim Ref. Design	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
Q10				3.1mw		10v	2N2369			
Q11				2.6mw		10v	2N3906			
Q12				0.22		6v	2N2222			
Q13				0.2		10v	2N2222			
R1		500	5%	1.6mw	150	0.9v		X		
R2		10K	5%	10mw	100	10v		X		
R3		500	5%	1.6mw	150	0.9v		X		
R4		10K	5%	10mw	100	10v		X		
R5		500	5%	1.6mw	150	0.9v		X		
R6		10K	5%	10mw	100	10v		X		

Rad Component Information

Engineer J Kravetz

Extension X1417

Circuit Name DO 28 CONTROL 3A

P/N 4026159

Date 8/19/77

Relim Ref. Design	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
R7		500	5%	1.6mw	150	0.9v		X		
R8		5K	5%	20mw	100	10v		X		
R9		500	5%	1.6mw	150	0.9v		X		
R10		5K	5%	20mw	100	10v		X		
R11		500	5%	1.6mw	150	0.9		X		
R12		5K	5%	20mw	100	10v		X		
R13		500	5%	1.6mw	150	0.9		X		
R14		5K	5%	20mw	100	10v		X		
R15		500	5%	1.6mw	150	0.9		X		
R16		5K	5%	20mw	100	10v		X		
R17		500	5%	1.6mw	150	0.9		X		

Engineer J. KravetzExtension X1417Circuit Name DO 28 CONTROL 3AP/N 4026159Date 8/19/77

Relim Ref. Design	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
R18		500	5%	1.6mw	150	0.9v		X		
R20		10K	5%	10mw	100	10v		X		
R21		5K	5%	20mw	100	10v		X		
R22		3K	5%	0.27mw	150	0.9v		X		
R23		50K	5%	2mw	100	10v		X		
R24		20K	5%	0.1mw	100	0.9v		X		
R25		50K	5%	2mw	100	9v		X		
R26		15K	5%	7mw	100	10v		X		
R27		5K	5%	0.2mw	100	0.9v		X		
R28		5K	5%	5mw	100	6v		X		

ORIGINAL PAGE IS
OF POOR QUALITY

Component Information

Engineer J. Kravitz

Extension X1417

Circuit

Name: DO 28 CONTROL 3A

P/N 4026159

Date 8/15/77

[illegible]

IC's

equiv = of comp

U1	4013	8
U2	4013	8
U3	4011	8
U4	4023	8
U5	4027	8
U6	4049	8
U7	4001	8
U8	4047	8
U9	4047	8
U10	4047 -	8

DIODES

CR1 - CR10	1N914	10
------------	-------	----

ZENER DIODES

VR1		1
-----	--	---

Transistors

Q1 Q11	2N3906	2
Q2, Q3, Q4	2N3904	3
Q5 Q6 Q7 Q8	2N2369	6
Q9 Q10		
Q12, Q13	2N2222	2

Resistors (32)	48
----------------	----

ORIGINAL PAGE 17
OF POOR QUALITY

TOTAL	152
-------	-----

Pin-outs - 34

II Power Analysis

(2)

A. TYPICAL Power (Quiescent Power - only clock running)

<u>Ic's</u>		<u>mw</u>	
u1	4013	1.2	
u2	4013	1.2	
u3	4011	0.06	
u4	4023	0.06	
u5	4027	1.2	
u6	4049	3.3	$[(0.3) + (1)(3)]$
u7	4001	0.06	
u8	4017	0.5	
u9	4047	0.5	
u10	4047	0.5	
		8.58	

Transistors

Q1 → Q5	0
Q10	1.0
Q11	0
Q12	0
Q13	0.9
	1.9 mw

$$P = [(0.7)(2.3mA) + (0.2)(2mA)] 50\% = 1.0 \text{ mw}$$

Diodes

CR1 → CR10	0
VR1	5 mw

Resistors

R1 → R15		0
R16	$\frac{(10)^2 (.5)}{5K} =$	10 mW
R17	$\frac{(0.7)^2 (.5)}{5K} =$	0.49
R18 → R22	-	0
R23 → R25		0
R26	$\frac{10^2}{15K}$	6.6 mW
R27	$\frac{(0.7)^2}{5K}$	0.1
R28	$\frac{5^2}{5}$	5 mW
R29 → R32		<u>0</u>
		22.19

TOTAL

37.67 mW

B Worst Case Power

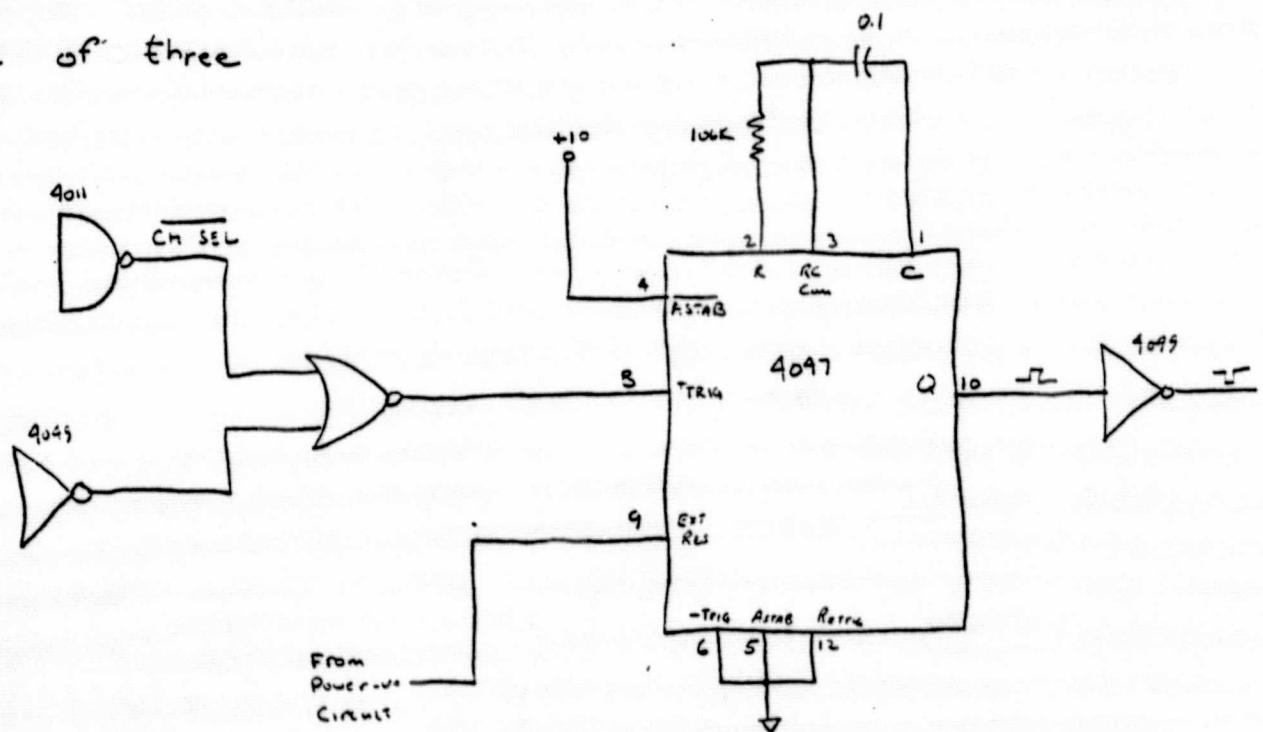
The worst case power will be the same as the old worst case power (Analysis package done to Rev E) plus the power dissipated in the power-up circuit, plus the worst case powers of U7, U8, U9 & U10 (Quiescent) minus the power dissipated in Q5, R11, Dynamic U4 & R12 (old designations referred to in previous analysis package) and plus the dynamic power of U2.

$$49.203 \text{ mw} + 17.7 \text{ mw} + 18.06 \text{ mw} - 0.967 \text{ mw} + 0.2 \text{ mw} = 84.196 \text{ mw}$$

$$\text{Worst Case Power} = \underline{84.196}$$

The circuit analysis will be the same as in the previous DO 28 control 3 ; Part No. 4020 315 analysis package (Analysis done to rev E) . However there are some additions due to the additional circuitry.

One of three



It is required that the width of the pulse out of Q (Pin 10) be 20ns to 35 nsec Long.

nominal case

$$\text{Pulse width} = 2.43 RC$$

$$= 26.28 \text{ msec}$$

adding tolerances

Device	- 0% ,	+ 9.3%
Resistor	- 2%	+ 2%
Capacitor	- 15%	+ 15%
temp of Device	- 5%	+ 5%
	- 22%	+ 31.3%

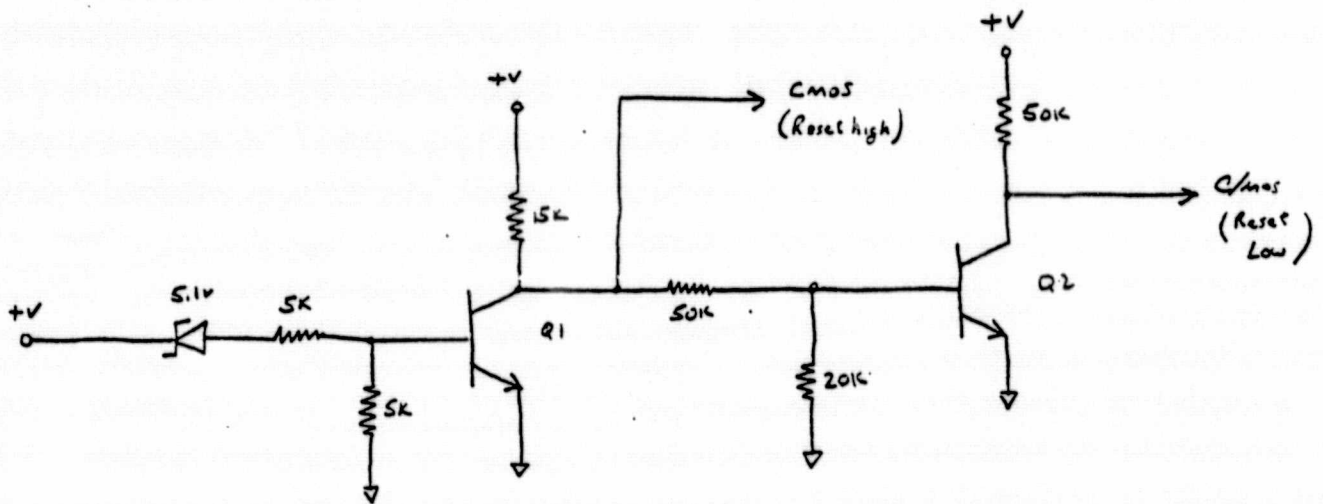
Worst case pulse width

$$\begin{aligned} \text{max} &= 20.4 \text{ ms} \\ \text{min} &= 34.5 \text{ ms} \end{aligned}$$

ORIGINAL PAGE IS
OF POOR QUALITY

Power-Up Circuit

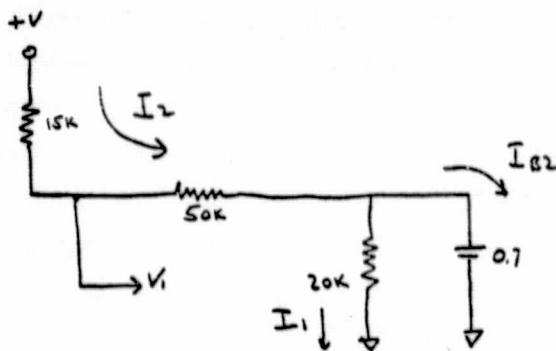
7



Room Temp - Nominal Case

Assume Q1 off $\Rightarrow V < 5.1V$

$V = 4V$



$$I_2 = \frac{4 - 0.7}{65K} = 0.050 \text{ mA}$$

$$= 50 \mu A$$

$$I_1 = \frac{0.7}{20K} = 0.035 \text{ mA}$$

$$= 35 \mu A$$

$$I_{02} = I_2 - I_1$$

$$= 50 \mu A - 35 \mu A$$

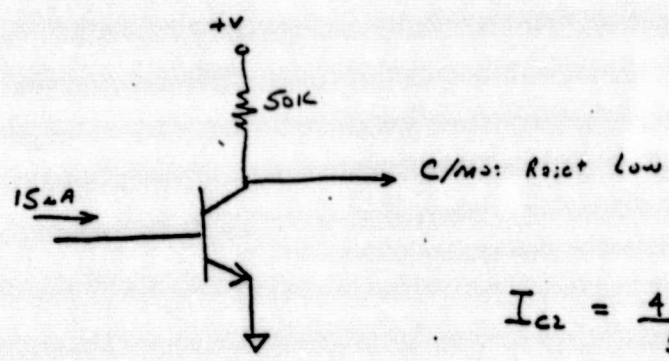
$$= 15 \mu A$$

$$V_1 = V - (I_2)(15K)$$

$$= 4 - (0.050)(15K)$$

$$= 3.25 \text{ volts}$$

ORIGINAL PAGE IS
OF POOR QUALITY



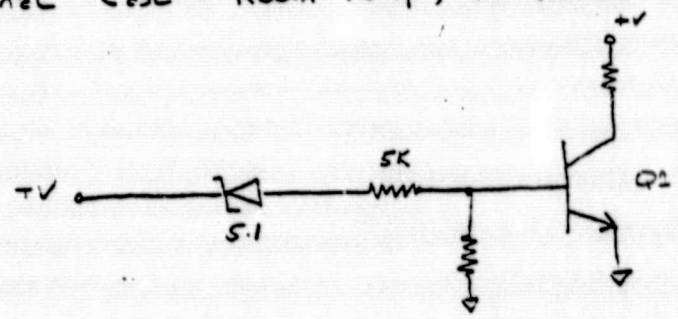
$$I_{C2} = \frac{4 - 0.1}{50k} = 0.078 \text{ mA}$$

$$= 78 \mu\text{A}$$

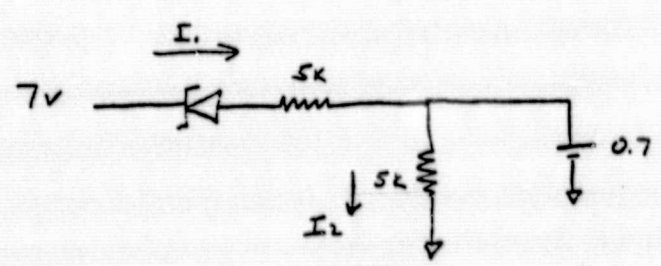
$$\beta_{avg} = \frac{78 \mu\text{A}}{15 \mu\text{A}} = 5.2 \quad (0^\circ\text{K})$$

Nominal Case - Room Temp, Q1 turned on

$$V > 5.1$$



With $V=7$, $Q1 \Rightarrow$ on



$$I_1 = \frac{7 - 5.1 - 0.7}{5k} = \frac{1.2}{5k} = 0.24 \text{ mA}$$

$$= 240 \mu\text{A}$$

$$I_2 = \frac{0.7}{5k} = 0.14 \text{ mA}$$

$$I_B = 240 \mu A - 140 \mu A = 100 \mu A$$

$$I_C = \frac{7}{15K} = 0.466 \text{ mA}$$

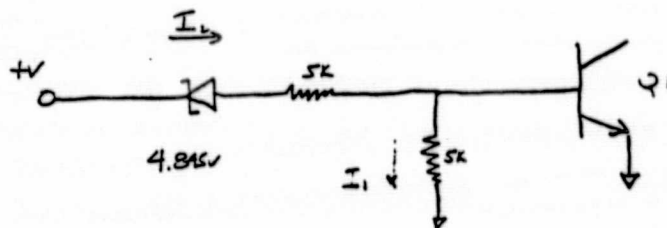
$$\beta_{\text{req}} = \frac{466 \mu A}{100 \mu A} = 4.66$$

Hot - Worst Case

$$V < V_2$$

$V_{\text{zener}} = \text{minimum}$

$$I_1 = \frac{0.35V}{5K} = 0.070 \text{ mA} \\ = 70 \mu A$$



For the CMOS to work V has to be greater than 3V

∴ With $3 < V < 4$ the Leakage through the Zener has to

$$\text{be } I_Z < 70 \mu A$$

From Zener spec: Max reverse leakage current

$$I_R (\mu A) = 10 \\ @ V_R (V) = 3$$

COLD - Worst Case Power Up

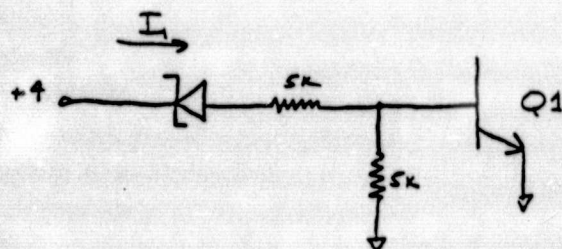
$$V < V_z$$

10

$$\text{temp } C_0 \Rightarrow V_z \Rightarrow 0.025 \text{ } ^\circ\text{C}^{-1}$$

$$V = 4 \text{ V}$$

$$V_z = 5.1 - 5\% - (45^\circ\text{C})(0.025 \text{ } ^\circ\text{C}^{-1}) = 3.72$$



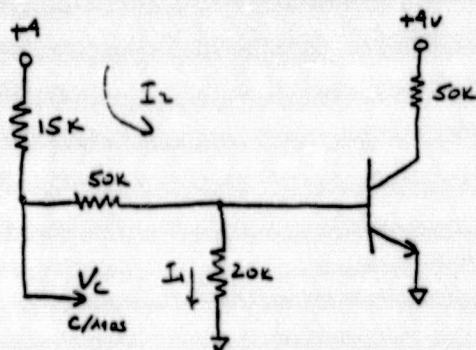
$$I_1 = \frac{4 - 3.72 - 0.85}{5\text{K}} = 0$$

Leakage would have to exceed

$$\frac{0.85}{5\text{K}} = 0.17 \mu\text{A}$$

Q1 should stay turned-off

COLD (Q1 turned off)
V = 4V



$$I_2 = \frac{4 - 0.85}{65\text{K}} = \frac{3.15}{65} = 0.048 \text{ mA}$$

$$I_1 = \frac{0.85}{20\text{K}} = 0.042 \text{ mA}$$

$$I_{B2} = 48 \mu\text{A} - 42 \mu\text{A} = 6 \mu\text{A}$$

$$I_{C2} = \frac{4\text{V}}{50\text{K}} = 80 \mu\text{A}$$

$$\beta_{\text{req}} = \frac{80 \mu\text{A}}{6 \mu\text{A}} = 13.3 \text{ should be } 0.1\text{K}$$

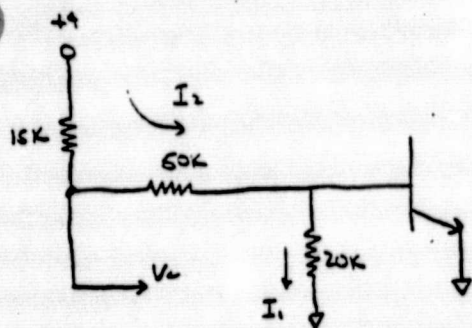
$$V_c = 4 - I_2 (15\text{K})$$

$$= 4 - (0.048 \text{ mA})(15\text{K})$$

$$= 3.28 \text{ V}$$

(3V is minimum)

Hot $V = 4V$ $Q1$ turned off



$$I_2 = \frac{4 - 0.35}{65K} = 56\mu A$$

$$I_1 = \frac{0.35}{20K} = 0.0175mA$$

$$I_0 = 38.5\mu A$$

$$I_C = \frac{4V}{50K} = 80\mu A$$

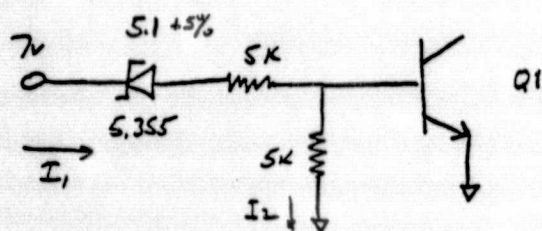
$$\beta_{req} = \frac{80}{38.5} = 2.07$$

$$V_C = 4 - (56\mu A)(15K)$$

$$V_C = 3.16V$$

Worst Case Cold Turn on of Q1 $V > V_z$

Assume $V = 7V$



$$I_1 = \frac{7 - 5.355 - 0.85}{5K} = 0.159 \text{ mA}$$

$$I_2 = \frac{0.85}{5K} = 0.17 \text{ mA} \Rightarrow Q1 \text{ will not turn on}$$

If $V = 8V$

$$I_1 = \frac{8 - 5.355 - 0.85}{5K} = 0.359 \text{ mA}$$

$$I_2 = \frac{0.85}{5K} = 0.17 \text{ mA}$$

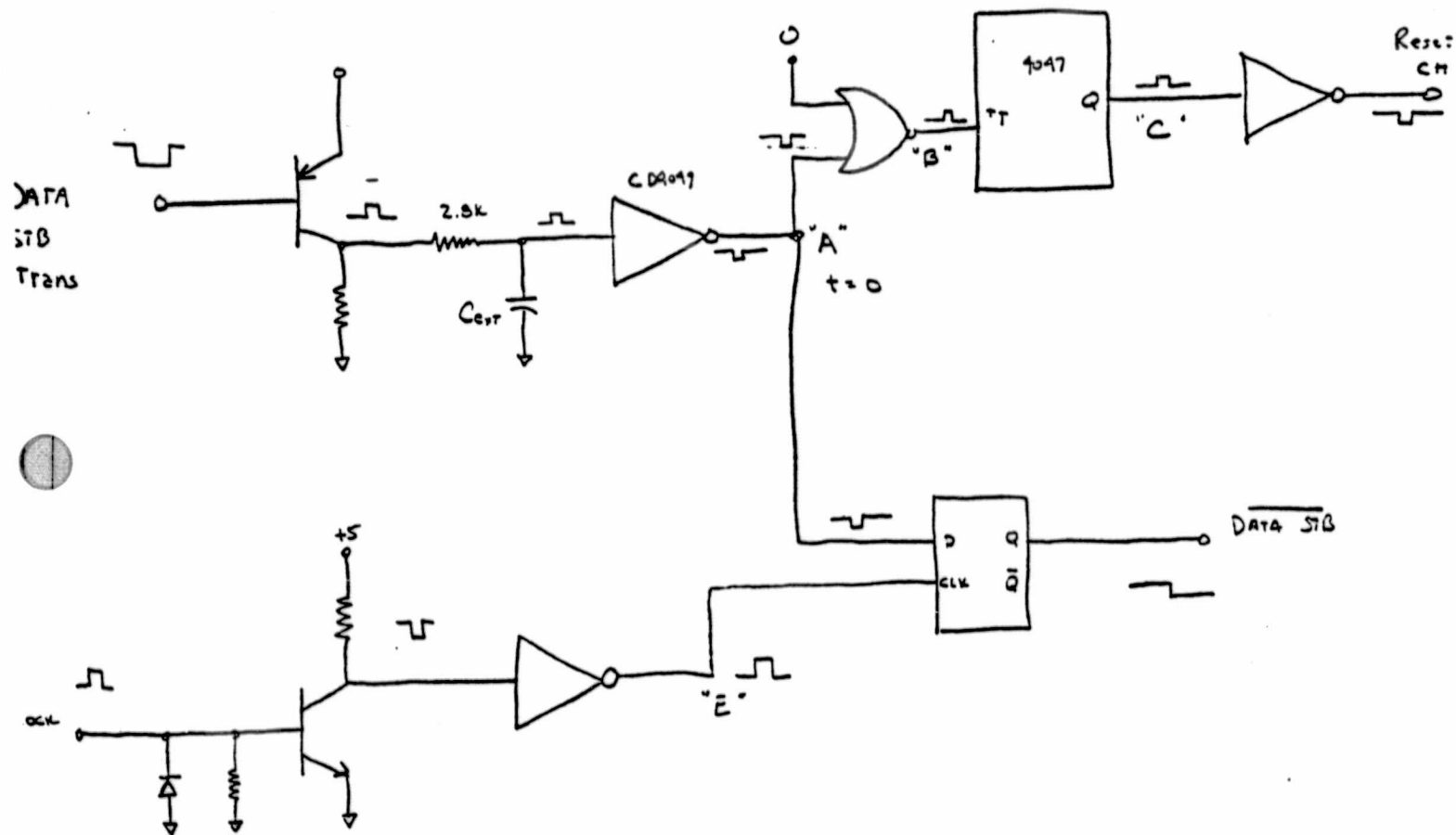
$$I_B = 0.359 - 0.17 = 0.189 \text{ mA}$$

$$I_C = \frac{8}{15K} = 533 \mu\text{A}$$

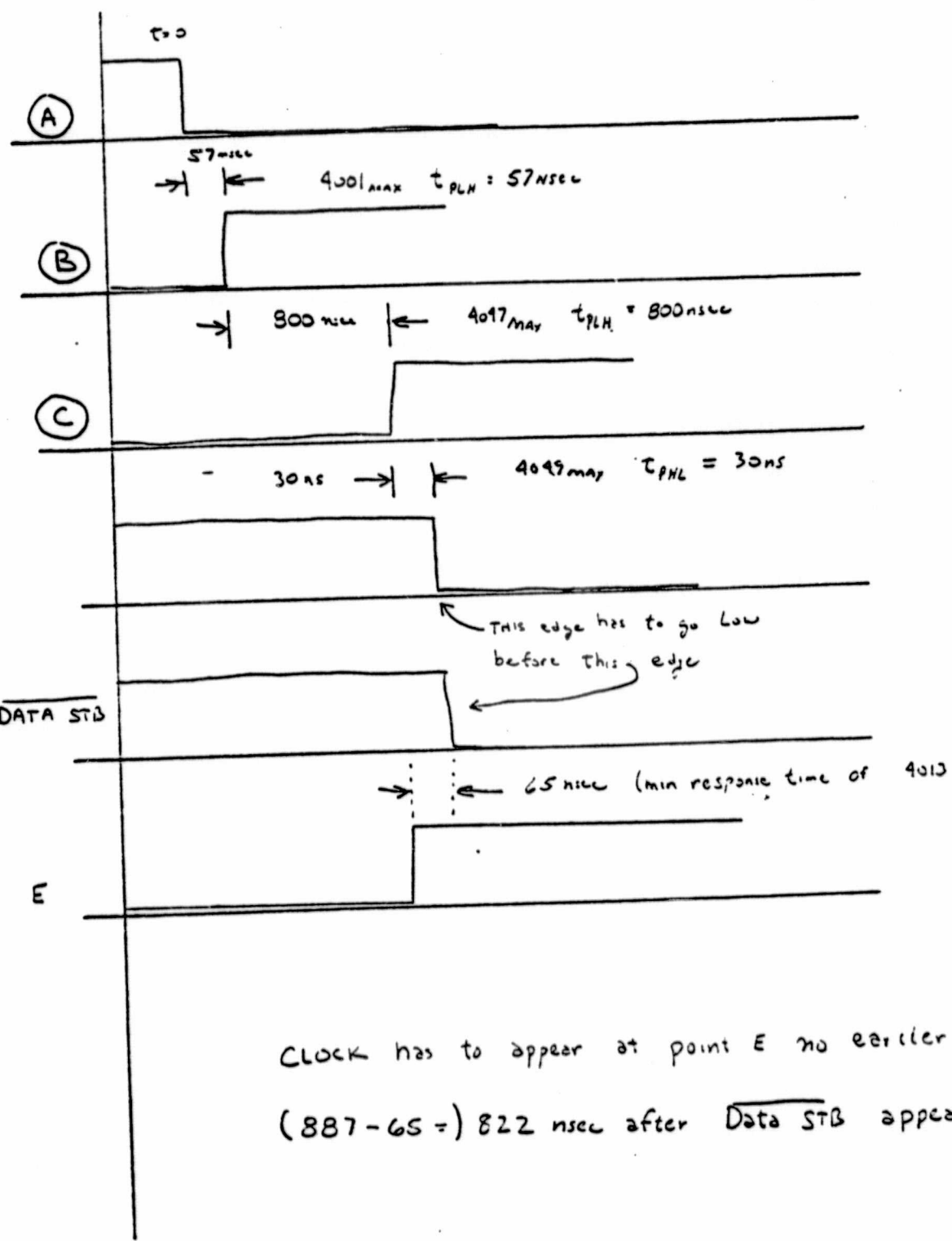
$$\beta_{reg} = \frac{533 \mu\text{A}}{189 \mu\text{A}} = 2.8$$

ORIGINAL PAGE IS
OF POOR QUALITY

- There was concern expressed that the falling edge on reset channel would not occur before the falling edge of DATA STB



ORIGINAL PAGE IS
OF POOR QUALITY



CLOCK has to appear at point E no earlier then
(887-65=) 822 nsec after Data STB appears at point 'A'

APPENDIX II

HYBRID ANALYSIS DATA SHEET -

D028 DRIVER 2

HYBRID REQUEST DATA SHEET

1. Name of Circuit: DO 28 Driver 2 Requestor: J. L. DeRuiter
Part Number: 4026161 Date: 8/19/77 Dept: 5820
Ext: 1445 Mail Station: T-2
2. Charge Number for Development and Prototypes: A.O. Number: 230662
Prod. No. _____

3. Quantity Usage:

3.1 Prototypes:

3.1.1 No. Required: 17

3.1.2 Date Required: 12/27/77

3.2 Production:

3.2.1 No. Required: 30

3.2.2 Date Required: 3/23/78

4. System Requirements:

4.1 System Operating Temperature Range: -10° °C to +71 °C

4.2 System Storage Temperature Range: -65 °C to +125 °C

4.3 Special System Requirements: Do not short 28 volt
outputs. There is no short circuit protection.

5. Circuit Requirements:

5.1 Case Operating Temperature Range: -20 °C to +100 °C

5.2 Circuit Schematic: (Attach separate sheet)

PRECEDING PAGE BLANK NOT FILMED

ORIGINAL PAGE IS
OF POOR QUALITY

5.3 Component Information (attach separate sheet)

5.3.1 Resistors:

- a) Value
- b) Tolerances
- c) Power Dissipation (worse case)
- d) Temperature Coefficient of Resistance (TCR)
- e) Voltage across resistor

5.3.2 Capacitors:

- a) Value
- b) Tolerances
- c) Working Voltage (DC)
- d) Temperature Characteristics

5.3.3 Transistors, Diodes and Integrated Circuits:

- a) Standard 1N, 2N or IC numbers
- b) Power Dissipation (worse case)

5.3.4 State any unusual electrical problems such as component proximity, sensitive lead, etc.:

5.3.5 Non-preferred Components Utilized: (Specify non-preferred/single source components used; i.e., Device and Source).

5.4 Circuit Power Dissipation:

5.4.1 310 m watts (average)

5.4.2 943 m watts (worse case)

ORIGINAL PAGE IS
OF POOR QUALITY

5.5 Has the circuit been worst-case analyzed for variation in component characteristics?

yes

no

6. Circuit Testing:

6.1 Has the circuit been tested over the circuit operating operating temperature range (para. 5.1) for worst-case variation in component characteristics?

yes

no 100m temp only

6.2 Did the circuit meet all requirements in the above temperature testing?

yes

no

6.3 Test Specification (attach separate sheets)

7. This circuit has been reviewed by hybrid engineering for technical feasibility.

approved

disapproved

Hybrid Engineer: James E. Chaffin

Date: 20 Sept 77

Section Head: A. J. Dawson

Date: 21 Sept 77

Comments: Current limiter is will not protect the circuit in case of output shorts. We recommend that parts associated with the current limiter be eliminated to reduce layout time, increase yield, & decrease cost.

8. Engineering approval:

Section Head: A. McDonald (over for additional comments)

Date: 22 Sept 77

Department Head: R. H. Hargrave

Date: 23 Sept 77

Manager: R. L. K. K. K.

Date: 23 Sept 77

Test results indicate the desirability of retaining the short circuit protection circuitry. Transient shorts are provided some protection (up to 1 minute) as shown by actual test. Based upon this and customer concern the protection circuitry should be retained. Quantities required for the FMDM program are small and yield improvement would result in negligible savings.

ORIGINAL PAGE IS
OF POOR QUALITY

HYBRID CHECK LIST

Hybrid Name Da 28 Driver 2 Part Number 4026161
Requester _____ System Application _____

Analysis

	<u>Schedule</u>	<u>Actual</u>
Hybrid Request Received		
DPA's submitted for new SCD's (_____)		<u>NA</u>
MI Release for parts coverage		<u>9-19-77</u>
Analysis Complete		<u>9-20-77</u>
Maximum T_j <u>125°C</u> @ $T_c = 104°C$		
Maximum Voltage stress:		
IC's (%)	<u>66%</u>	
Transistors (%)	<u>20%</u>	
Diodes (%)	<u>28%</u>	
Capacitors (%)	<u>32%</u>	
Resistors (%)	<u>62%</u>	
Maximum current stress:		
Transistors (%)	<u>5.4%</u>	
Diodes (%)	<u>6.5%</u>	
Bond wire - peak (ma)	<u>210mA</u>	
- duty cycle (%)	<u>20%</u>	
Analysis signed off by project	_____	_____

HYBRID CHECK LIST

Page 2

Hybrid Name DO 28 Driver 2Part Number 4026161Design and Evaluation

	<u>Schedule</u>	<u>Actual</u>
DPA to design	<u>9-23-77</u>	
New die layouts available	<u>N/A</u>	<u>N/A</u>
Test spec to typing		
Line plots complete (Pin outs available)		
Artwork to manufacturing		
Short test probe cards complete		
Static trim program & probe card complete		
Print and trim complete (Eng. evaluation)		
Dynamic trim program and card complete		
ATE test program complete		
Engr. evaluation unit complete		
Burn-in board design complete		
Burn-in boards () complete		
Test spec release		
SCD Release		
Schematic release		
Hybrid drawing release		

Hybrid Check List

Hybrid Name _____ * _____ Part Number _____ * *
Requester _____ * _____ System Application _____ *

Analysis

Hybrid Request Received
DPA's submitted for new SCD's (**) MI Release for parts coverage
Analysis Complete

Schedule	Actual
茶	茶
火腿	火腿
收銀	收銀
送金	送金

Maximum T_j _____ @ $T_c =$ _____

Maximum voltage stress:

IC's (%) **

Worst case Transistors (%)	95%
100	100

device Diodes (%) # of

Crossfitters (%)

Resistors(%) **

1V/mill Resistors (%) **

Maximum current stress:

Transistor 2 (%) 44

Diodes(%)	4.4
-----------	-----

worst wire common Bond wire - peak (ma) **

- duty cycle (%) 4.4

Analysis signed off by project

大数 △

- * Filled in by D. Lawson when request received.
- ** Filled in by hybrid engineer before submitting package for sign off.
- *** Filled in by D. Lawson when submitted for sign off.
- Δ Filled in by hybrid engineer—in conjunction with M.E.—Immediately upon receipt of the signed off package.
- ΔΔ Filled in by hybrid engineer as accomplished.

ORIGINAL PAGE IS
OF POOR QUALITY

Hybrid Drawing List

Hybrid Name _____ * _____ Part Number _____ **

Design and Evaluation

Schedule Actual

DPA to design	**	ΔΔ
New die layouts available	**	
Test Spec to typing	Δ	
Line plots complete (Pin outs available)		
Artwork to manufacturing		
Short test probe cards complete		
Static trim program & probe card complete		
Print and Trim complete (Engr. evaluation)		
Dynamic trim program and card complete		
A TE test program complete		
Engr. evaluation unit complete		
Burn-in board design complete		
Burn-in boards (*) complete		
Test Spec release		
SCD Release		
Schematic Release		
Hybrid drawing release	Δ	ΔΔ

Hy Component Information

Engineer Jim Schaeffer

Extension 1417

Circuit

Name DO 28 Driver 2

P/N 40 26161

Date 7 Sept 77

mw

elim ef. sion	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
R1		5	10	17	200	1V		✓		
R2		2K	5	.5	100	1V		✓		
R3		9K	2	92	100	32V		✓		
R4		30K	5	3.5	100	10V		✓		
R5		30K	5	22	400	30V		✓		
R6		100K	5	10	100	32V		✓		
R7		15K	5	.1	100	1V		✓		
R8		5K	5	4	100	11V		✓		
R9		5	2	17	200	1V		✓		
R10		2K	.5	.5	100	1V		✓		
R11		9K	2	92	100	32V		✓		

ORIGINAL PAGE IS
OF POOR QUALITY

Hybrid Component Information

Engineer Jim SchaefferExtension 1417Circuit
NameDO 28 DRIVER 2

P/N

4026161

Date

7 Sept 77

mw

elim ref. sign	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
R12		30K	5	3.5	100	10V		✓		
R13		30K	5	22	100	30V		✓		
R14		100K	5	10	100	32V		✓		
R15		15K	5	.1	100	1V		✓		
R16		5	2	17	200	1V		✓		
R17		5K	5	4	100	11V		✓		
R18		2K	5	.5	100	1V		✓		
R19		9K	2	92	100	32V		✓		
R20		30K	5	3.5	100	10V		✓		
R21		30K	5	22	100	30V		✓		
R22		100K	5	10	100	32V		✓		

Hybrid Component Information

Engineer Jim SchaefferExtension 1417

Circuit

Name

DO 28 DRIVER 2

P/N

4026161

Date

7 Sept 77

mW

elim af. sion	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
R23		15K	5	.1	100	1V		✓		
R24		5	2	17	200	1V		✓		
R25		5K	5	4	100	11V		✓		
R26		2K	5	.5	100	1V		✓		
R27		9K	2	92	100	32V		✓		
R28		30K	5	3.5	100	10V		✓		
R29		30K	5	22	100	30V		✓		
R30		100K	5	10	100	32V		✓		
R31		15K	5	.1	100	1V		✓		
R32		5K	.5	4	100	11V		✓		
R33		15K	5	7	100	11V		✓		

ORIGINAL PAGE IS
OF POOR QUALITY

Hyb. Component Information

Engineer Jim SchaefferExtension 1417

Circuit

Name

DO 29 Driver 2

P/N

4026161

Date

7 Sept 77

mW

elim ef. sion	Final Ref. Desion	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
Q1				.3		2 V	2N3906			
Q2				15		32 V	2N4033			
Q3				1		32 V	2N2222A			
Q4				1		11 V	2N3822			
Q5				1.5		15 V	2N2945A			
Q6				.3		2 V	2N3906			
Q7				15		32 V	2N4033			
Q8				1		32 V	2N2222A			
Q9				1		11 V	2N3822			
Q10				1.5		15 V	2N2945A			
Q11				.3		2 V	2N3906			

Hybrid Component Information

Engineer Jim SchaeferExtension 1417

Circuit

Name DO 2-8 Driver 2P/N 4026161Date 7 Sept 77

mW

Lim Ref. tion	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
Q ₁₂				15		32 V	2N4033			
Q ₁₃				1		32 V	2N2222A			
Q ₁₄				1		11 V	2N3822			
Q ₁₅				1.5		15 V	2N2945A			
Q ₁₆				.3		2 V	2N3906			
Q ₁₇				15		32 V	2N4033			
Q ₁₈				1		32 V	2N2222A			
Q ₁₉				1		11 V	2N3822			
Q ₂₀				1.5		15 V	2N2945A			
Q ₂₁				1.5		11 V	2N2222A			
CR1				55		10 V	1N914			

ORIGINAL PAGE IS
OF POOR
QUALITY

Hyb Component Information

Engineer Jim SchaefferExtension 1417

Circuit

Name

DO 28 Driver 2

P/N

4026161

Date

7 Sept 77

mW

elim af. sion	Final Ref. Design	Value	(%) Tol.	Max. Power Diss.	ppm/°C TCR	Max. Voltage	Indust Type	Static Trim	Dynamic Trim	REMARKS
CR2				small		1 V	1N914			
CR3				1		1 V	1N914			
CR4				55		10V	1N914			
CR5				small		1 V	1N914			
CR6				1		1 V	1N914			
CR7				55		10V	1N914			
CR8				small		1 V	1N914			
CR9				1		1 V	1N914			
CR10				55		10V	1N914			
CR11				small		1 V	1N914			
CR12				1		1 V	1N914			

ORIGINAL PAGE IS
OF POOR QUALITY

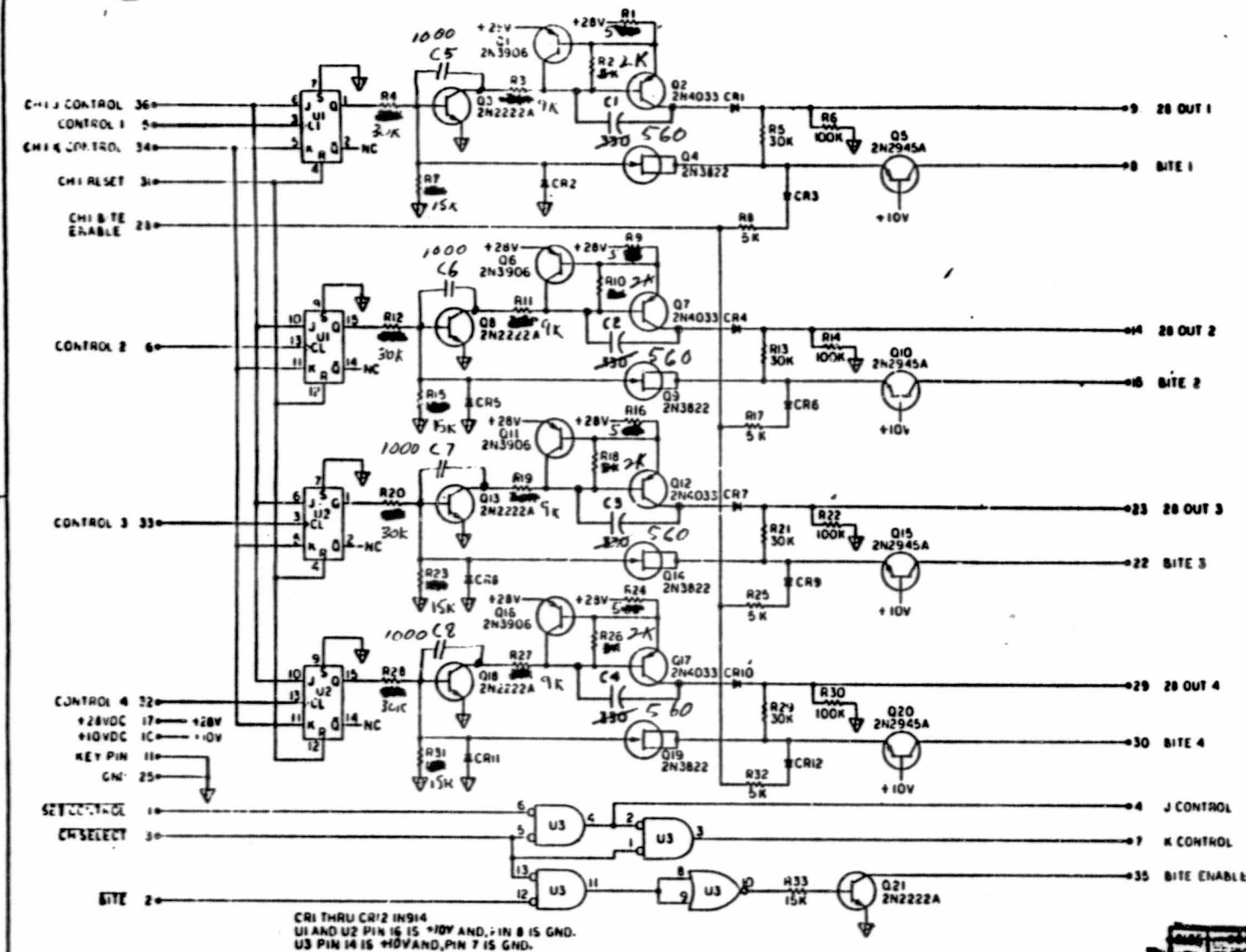
PROTO

ENG. COPY

JUL 28 1976

DO28 DRIVER 2
5800 MONT-509

REV	4020297
-----	---------



Conclusions

DOZE DRIVER 2

P/N 4026161

The 28 volt outputs of this hybrid should not be shorted as there is no short circuit protection.

The overdrive factor of 2 may not be met by Q2 and Q3 under worst case conditions. They should saturate however and this meets the requirements of the designer.

The circuit will not supply 50mA to a 580 Ω load. It should have no trouble supplying 50mA to a smaller load such as 540 Ω with $V_{supply} = 28V$.

This analysis was done using worst case temperatures of $-55^{\circ}C$ and $+125^{\circ}C$. Results are worse than should be expected over the actual operating temperature range of $-20^{\circ}C$ to $+100^{\circ}C$.

ORIGINAL PAGE IS
OF POOR QUALITY

DO 28 DRIVER 2
P/N 4026161
Requirements

- ① 10-100 μ s rise & fall times
- ② high output $\geq$ 28 volt supply - 3.5V
- ③ Low output $\leq$ 3V
- ④ supply 50mA to a 520 Ω 5000pf Load
- ⑤ Pin compatible with DO 28 DRIVER
P/N 4020297

except for elimination of output LP1,
LP2

DO 26 DRIVER 2
PIN 4026161

(3)

1x1 Flat pack

NO of
devices

Type

value

5	2N2222A Trans	
4	2N4033 Trans	
4	2N2945A Trans	
4	2N3822 Trans	
4	2N23906 Trans	
12	1N914A Diode	
4	Capacitors	1000pF
4	Capacitors	560pF
2	DUAL JK Master slave Flip Flops	CD4027A
1	Quad 2 input NOR Gate	CD4001A

Component count

	NO	Count
RS	33	33
CR	12	12
T	21	21
C	9	24
		<u>90</u>

U1 6

U2 6

U3 5
17

Total 107

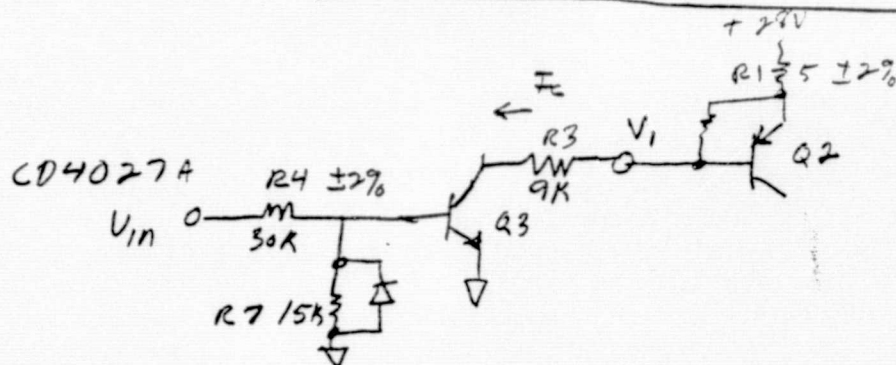
Pin count
28

3 Resistor 1.5k

5.5 2K CH10
10K
50K

ORIGINAL PAGE IS
OF POOR QUALITY

Calculating saturation of Q3 turned on



200ppm α -55 = 1.6%
100ppm .2%

NOMINAL 25°C

$$I_C = \frac{V_1 - V_{CE3}}{9K}$$

$$V_1 = V_S - I_{E1} R_1 - V_{BE2}$$

$$I_{E1} \approx 52\mu A$$

$$V_1 = 28 - 52m(5) - .9$$

$$= 26.84$$

$$I_C = \frac{26.84 - .1V}{9K}$$

$$I_C = 2.97mA$$

Over Drive = 2

$$2 = \frac{.9(75)}{2.97m / I_{BQ}}$$

$$I_{BQ} = 88\mu A$$

$$I_{B \text{ actual}} = \frac{V_{in} - V_{BE3}}{R_4} - \frac{V_{BE3}}{R_7}$$

$$= \frac{10 - .65}{30K} - \frac{.65}{15K}$$

$$I_{B \text{ actual}} = 268\mu A$$

$I_{B \text{ actual}} \gg I_{BQ}$ so Q3 will saturate at Nominal temp

Worstcase
-55°C

$$V_1 = V_S - I_{E1} R_1 - V_{BE2}$$

$$= 32 - 52m(5) - (.9 + 2m(80))$$

$$= 32 - .26 - 1.06$$

$$= 30.68$$

$$I_C = \frac{V_1 - V_{CE3}}{R_3}$$

$$= \frac{30.68 - .2}{9K - 5\% + .8\%}$$

$$I_{CWC} = 3.535mA$$

Over Drive = 2

$$2 = \frac{.9(35)(.85)}{3.535m / I_{BQ}}$$

$$I_{BQ} = 264\mu A$$

$$I_{\text{actual}} = \frac{V_{in} - V_{BE3}}{R_4} - \frac{V_{BE3}}{R_7}$$

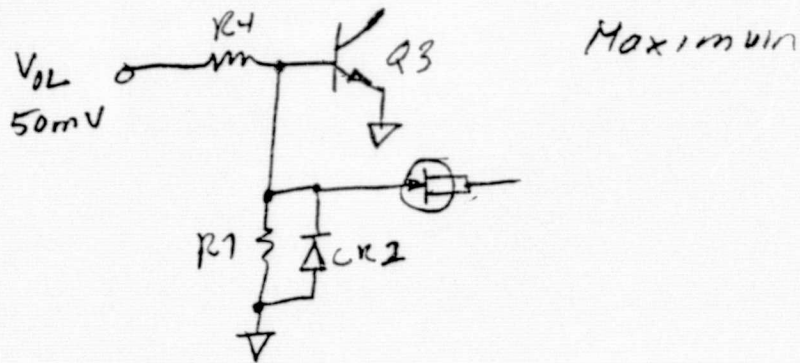
$$= \frac{9.45 - .9}{5K + 3.6\%} - \frac{.9}{15K - 4.7\%}$$

$$I_{\text{actual}} = 218\mu A \quad I_{\text{act}} \leq I_{BQ}$$

doesn't quite meet overdrive of 2 but Q3 should still saturate at Worst case. (*) see conclusion

turn off of Q_3 at high temp (125°C)

⑤



$$\begin{aligned}
 V_{BE3} &= V_{OL} + (I_D + I_{EB03} + I_{GSS})_{\max} (15K + 1\%) \\
 &= 50\text{mV} + (320\text{nA} + 320\text{nA} + .1\mu\text{A}) 15.15K \\
 &= 50\text{mV} + 11\text{mV}
 \end{aligned}$$

$$V_{BE3} = 61\text{mV}$$

$V_{BE3\text{ off}} \ll .3\text{V}$ so Q_3 will be off at 125°C

(6)

$$\textcircled{1} \quad V_s = I_{E2} (R_1) + V_{BE2} + I_{C3} R_3 + V_{CE3sat}$$

$$\textcircled{2} \quad I_{C3} = I_{B2} + \frac{V_{BE2}}{R_2}$$

$$\textcircled{3} \quad I_{E2} = I_{B2} + I_{C2}$$

$$\textcircled{4} \quad I_{C2} = I_0 + \frac{V_0}{R_6} + \frac{V_0 \cdot -9.5V}{R_5}$$

$$\textcircled{5} \quad V_0 = V_s - I_{E2} R_1 - V_{CE2sat} - V_{D1}$$

$$5.43 \quad V_0 = V_s - (I_{B2} + I_{C2}) (R_1) - V_{CE2sat} - V_{D1}$$

$$5.3.41 \quad I_{C2} = I_0 + \left[\frac{V_s - (I_{B2} + I_{C2}) R_1 - V_{CE2sat} - V_{D1}}{R_6} \right]$$

$$+ \left[\frac{V_s - (I_{B2} + I_{C2}) R_1 - V_{CE2sat} - 9.5V}{R_5} \right]$$

$$\begin{aligned} I_{C2} = I_0 + \frac{V_s}{R_6} - \frac{R_1}{R_6} (I_{B2}) - \frac{R_1}{R_6} I_{C2} - \frac{V_{CE2sat}}{R_6} - \frac{V_{D1}}{R_6} \\ + \frac{V_s}{R_5} - \frac{R_1}{R_5} (I_{B2}) - \frac{R_1}{R_5} I_{C2} - \frac{V_{CE2sat}}{R_5} - \frac{9.5V}{R_5} - \frac{V_{D1}}{R_5} \end{aligned}$$

$$I_{C2} + \frac{R_1}{R_6} I_{C2} + \frac{R_1}{R_5} I_{C2} = I_0 + V_S \left(\frac{1}{R_6} + \frac{1}{R_5} \right) - R_1 I_{B2} \left(\frac{1}{R_5} + \frac{1}{R_6} \right) - V_{CE2 sat} \left(\frac{1}{R_5} + \frac{1}{R_6} \right) - \frac{V_{D1}}{R_6} - \frac{9.5V}{R_5} - \frac{V_{D1}}{R_5}$$

$$I_{C2} \left(1 + R_1 \left(\frac{1}{R_5} + \frac{1}{R_6} \right) \right) =$$

$$\textcircled{6} I_{C2} = \frac{I_0 + \left(\frac{1}{R_6} + \frac{1}{R_5} \right) \left(V_S - R_1 I_{B2} - V_{CE2 sat} - V_{D1} \right) - \frac{9.5V}{R_5}}{1 + R_1 \left(\frac{1}{R_5} + \frac{1}{R_6} \right)}$$

5, 3, 4, 2, 1

ORIGINAL PAGE IS
OF POOR QUALITY

$$V_S = I_{E2} (R_1) + V_{BE2} + I_{C3} R_3 + V_{CE3 sat}$$

$$V_S = I_{B2} R_1 + R_1 \left[\frac{I_0 + \left(\frac{1}{R_5} + \frac{1}{R_6} \right) \left(V_S - R_1 I_{B2} - V_{CE2 sat} - V_{D1} \right) - \frac{9.5V}{R_5}}{1 + R_1 \left(\frac{1}{R_5} + \frac{1}{R_6} \right)} \right] + V_{BE2} + I_{B2} R_3 + \frac{V_{BE2} (R_3)}{R_2} + V_{CE3 sat}$$

$$V_S = I_{B2} (R_1) + I_{B2} (R_3) + V_{BE2} + V_{CE3 sat} + \frac{V_{BE2} (R_3)}{R_2}$$

$$- \frac{R_1^2 I_{B2} \left(\frac{1}{R_5} + \frac{1}{R_6} \right)}{1 + R_1 \left(\frac{1}{R_5} + \frac{1}{R_6} \right)} + R_1 \left[\frac{I_0 + \left(\frac{1}{R_5} + \frac{1}{R_6} \right) \left(V_S - V_{CE2 sat} - V_{D1} \right) - \frac{9.5V}{R_5}}{1 + R_1 \left(\frac{1}{R_5} + \frac{1}{R_6} \right)} \right]$$

$$\textcircled{7} I_{B2} \left(R_1 - R_3 + \frac{R_1^2 \left(\frac{1}{R_5} + \frac{1}{R_6} \right)}{1 + R_1 \left(\frac{1}{R_5} + \frac{1}{R_6} \right)} \right) = -V_S + V_{BE2} + V_{CE3 sat} + \frac{V_{BE2} (R_3)}{R_2} + R_1 \left[\frac{I_0 + \left(\frac{1}{R_5} + \frac{1}{R_6} \right) \left(V_S - V_{CE2 sat} - V_{D1} \right) - \frac{9.5V}{R_5}}{1 + R_1 \left(\frac{1}{R_5} + \frac{1}{R_6} \right)} \right]$$

Determining if Q2 12N4033 will saturate
using equations (6) & (7) for I_{B2} and I_{C2}

Nominal 25°C

$$\begin{aligned} V_S &= 28\text{V}, V_{BE2} = .8 \\ V_{CE2} &= .1, V_{CE3} = .1 \\ V_{D1} &= .9, R_1 = 5\Omega \\ R_2 &= 5\text{K}, R_3 = 9\text{K} \\ R_4 &= 30\text{K}, R_5 = 30\text{K} \\ R_6 &= 100\text{K} \end{aligned}$$

Eq. (7)

$$I_{B2}(-9005) = -28 + .8 + .1 + 3.6 + .25 + 6\text{m} - 22\mu - .194\text{m} - 1.59\text{m}$$

$$= -23.2456$$

$$I_{B2} = 2.58\text{mA}$$

Eq. (6)

$$I_{C2} = \frac{50\text{m} + 1.21\text{m} - .56\mu - 4.33\mu - 31\mu - .317\text{m}}{1.0002}$$

$$I_{C2} = 50.87\text{m}$$

Minimum required β to saturate Q2 at 25°C

$$\begin{aligned} \beta &= \frac{I_{C2}}{I_{B2}} \\ &= \frac{50.87\text{m}}{2.58\text{m}} \end{aligned}$$

$$\beta_{\text{min}} = 19.7 \text{ required}$$

At 25°C and $I_C = 100\text{mA}$ β for 4033 is ≈ 75

at $I_C = 50\text{mA}$ β will be about 80% of β at $I_C = 100\text{mA}$

$$\beta_{\text{actual}} = 75(.8) = 60 \quad \beta_{\text{actual}} > \beta_{\text{required}} \text{ so Q2 will saturate}$$

Worst case saturation of Q2 (-55°C)

(1)

$$\begin{aligned} V_S &= 32V, V_{BE2} = 1 & V_{D1} &= 1.1V, R_1 = 5R + 3.6\% = 5.19 \\ V_{CE2} &= 1V, V_{CE3} = 1 & R_2 &= 2K - 4.2\% = 1916, R_3 = 9K + 5.8\% = 9522 \\ R_5 &= 30K + 5.8\% = 31.74K & R_6 &= 100K + 5.8\% = 105.8K \end{aligned}$$

Eq 7

$$I_{B2}(-9522) = -V_S + 1 + 1 + 4.96 + .259 + 6.79m - .212m - 54\mu - 1.55m$$

$$= -24.27$$

$$I_B = 2.6mA \text{ for } V_S = 32 \quad 1.76mA \text{ for } V_S = 24$$

Eq 6

$$I_{C2} = \frac{50m + 1.31m - .55\mu - 41\mu - 10\mu - .3m}{1.0002} \quad (.99m \text{ for } V_S = 24, .36\mu \text{ for } 24)$$

$$I_{C2} = 50.95mA \text{ for } V_S = 32 \quad 50.61mA \text{ for } V_S = 24$$

$$\beta_{min} = \frac{I_{C2}}{I_B} = \frac{50.61mA}{1.76mA}$$

$$\beta_{min \text{ required for sat.}} = 28.76 \text{ at worst case low temp with } V_S \text{ reduced to } 24V$$

for a 2N4033 at -55°C and $I_C = 100mA$ $\beta_{min} = 40 (.85) = 34$ MDM Degrading factor
from typical curves β should be slightly higher at $I_C = 50mA$

$\beta_{actual} > \beta_{min \text{ needed}}$ so Q2 should saturate at worst case low temp (*) see conclusions

Output voltage (High Level)

(10)

Nominal 25°C

$$\begin{aligned} I_{E2} &= I_{B2} + I_{C2} \\ &= 50.87 \text{ mA} + 2.58 \text{ mA} \end{aligned}$$

$$I_{E2} = 53.5 \text{ mA}$$

$$\begin{aligned} V_0 &= V_s - I_{E2} R_1 - V_{CE2 \text{ sat}} - V_{D1} \\ &= 28 - 53.7 \text{ m}(5) - .1 - .9 \end{aligned}$$

$$\boxed{V_{0 \text{ nom}} = 26.7 \text{ V}} \quad \text{nominal output voltage}$$

Worst case -55°C

$$I_{E2} = I_{B2} + I_{C2}$$

$$= 2.91 \text{ mA} + 50.95 \text{ mA} \quad \text{for } V_s = 32 \text{ V}$$

$$I_{E2} = 53.55 \text{ mA}$$

$$= 1.44 \text{ mA} + 50.37 \text{ mA} \quad \text{for } V_s = 24 \text{ V}$$

$$I_{E2} = 52.4 \text{ mA}$$

$$V_0 = V_s - I_{E2} R_1 - V_{CE2 \text{ sat}} - V_{D1}$$

$$= 32 - 53.86 \text{ mA}(5.16) - .1 - .1$$

$$\boxed{V_{0 \text{ worstcase}} = 29.62 \text{ V}} \quad \text{for } V_s = 32 \text{ V}$$

$$V_0 = 24 - 51.8 \text{ m}(5.18) - .1 - .1$$

$$\boxed{V_{0 \text{ worstcase}} = 21.63 \text{ V}} \quad \text{for } V_s = 24 \text{ V}$$

in each case the output voltage is less than 3.5 V below V_s so the circuit meets the spec.

Turn off of Q2 at high temp

$$V_{BE2} = (I_{CB03} + I_{CB02}) R2$$

$$1.5 = 5K + 4\% \\ = 5.2K$$

$$I_{CB03} = 10 \mu A$$

$$\text{at } T_A = 150^\circ C$$

$$I_{CB02} = 50 \mu A$$

$$\text{at } T_A = 158^\circ C$$

value doubles every $10^\circ C$, so at $120^\circ C$

$$I_{CB03} = 1.25 \mu A \times 300\% \leftarrow \text{MDM Derating spec margin}$$

$$I_{CB02} = 6.25 \mu A \times 300\% \leftarrow \text{MDM Derating spec margin}$$

$$V_{BE2} = (1.25 \mu A \times 300\% + 6.25 \mu A \times 300\%) 5.2K$$

$$= (3.75 \mu A + 18.75 \mu A) 5.2K$$

$$V_{BE2_{wc}} = 117 \text{ mV}$$

V_{BE} must be 300 mV to turn on Q2 so it will remain off when it is supposed to

worst case low output voltage

$$V_0 = (I_{EB05} + I_{CB02}) R6$$

$$R6 = 100K (+4\%)$$

$$R6 = 104K$$

$$I_{CB02} = 50 \mu A$$

$$\text{at } 150^\circ C$$

$$I_{EB05} = 20 \text{ nA}$$

$$\text{at } 100^\circ C$$

} values double every $10^\circ C$

$$I_{CB02} = 6.25 \mu A$$

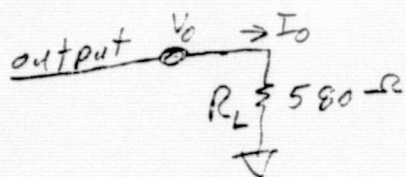
$$I_{EB05} = 80 \text{ nA}$$

ok because low output voltage spec is 3 volts

$$V_0 = (6.25 \mu A + 80 \text{ nA}) (104K) (300\% \text{ spec margin}) = 1.97 \text{ V} = V_0$$

Output load (*) see comment page 12

The circuit is supposed to supply 50mA to a load of $580\ \Omega$. However even with Nominal values you need an output voltage of 29V to supply 50mA. This is not possible when V_s is only 28V Nominal

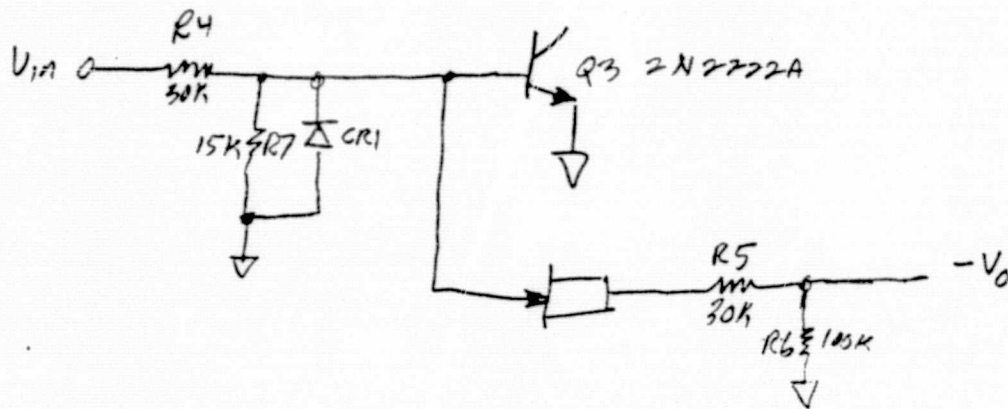


With $V_s = 28V$ V_o would be $\approx 26.7V$, so to supply 50mA to R_L , R_L would have to be $\leq 540\ \Omega$

For the case when the ship supply V_s drops to 24 volts, V_{out} could be only 18V and most spec so R_L of $\leq 360\ \Omega$ would be needed.

feedback turn off voltage

worst case



when $V_B = 0$

$$\frac{V_{in}}{R_4} = \frac{|V_o| - V_D}{R_5}$$

$$\frac{10.5}{30K} = \frac{|V_o| - 1.0V}{30K}$$

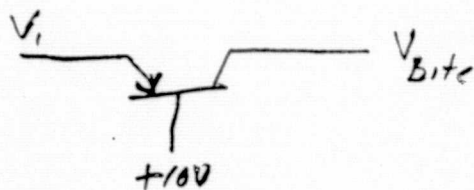
$$|V_o| = 11.5V$$

$V_o = -11.5V$ to turn off Q_3

ORIGINAL PAGE IS
OF POOR QUALITY

Voltage out at BITE outputs

(14)



$$V_{Bite} = 10V + V_{BE} - V_{CE}$$

N_{om} $V_{Bite} = 10V + .6 - .0004$

$$V_{Bite} = 10.6$$

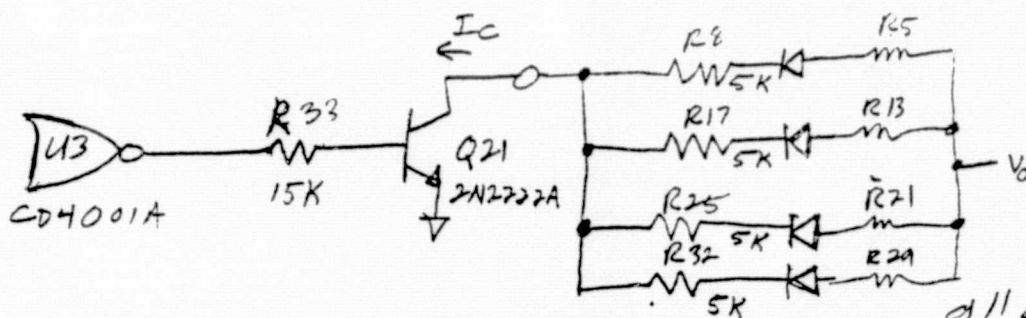
Worst case $-55^{\circ}C$

$$V_{Bite\ w.c.} = 10.5 + 1 - .0002$$

$$V_{Bite\ w.c.} = 11.50002\ V$$

Saturation of Q21 (2N2222A)

(15)



NOM Case 25°C

$$I_C = \frac{(V_0 - V_D)}{R_8 + R_5} \cdot 4$$

$$= \frac{(26.7 - .6)}{35K} \cdot 4$$

$$I_C = 3 \text{ mA}$$

$$\text{overdrive} = \frac{75(.8)}{I_C / I_{BF}}$$

$$2 = \frac{75(.8)}{3 \text{ mA} / I_{BF}}$$

$$I_{BF} = .1 \text{ mA}$$

needed to saturate Q21

Minimum Current drive of U3 at 25°C is .5mA x .15

∴ Q21 will saturate at 25°C

Turn off of Q21 at high temp

VOL of U3 = 50mV.

Voltage needed to turn on Q21 is .3V

∴ Q21 will turn off

Worst case -55°C

$$I_C = \frac{(26.62 - 1)}{35K - 5.8\%} \cdot 4$$

$$I_C = 3.5 \text{ mA}$$

$$\text{overdrive} = \frac{35(.9)}{3.5 \text{ mA} / I_{BF}}$$

$$2 = \frac{25(.2) (.85)}{3.5 \text{ mA} / I_{BF}} \quad \text{Derati}$$

$$I_{BF} = .26 \text{ mA}$$

needed to saturate Q21 Worst case with over drive factor of 2

$$I_{\text{bactual}} = \frac{V_{in} - V_{BE}}{R_8} = \frac{9.5 - 1}{15K + 5\%}$$

$$I_{\text{bactual}} = .54 \text{ mA}$$

$I_{\text{bactual}} > I_{BF}$ so transistor Q21 will saturate at -55°C

ORIGINAL PAGE IS OF POOR QUALITY

Power Calculations

(16)

Nominal

$$P_{R1} = (I_{E2})^2 R_1$$
$$= (53.7 \text{ mA})^2 (5)$$

$$P_{R1_N} = 14 \text{ mW}$$

$$P_{R2} = \frac{(V_{BE2})^2}{R_2}$$
$$= \frac{(.9)^2}{5K}$$

$$P_{R2_N} = .32 \text{ mW}$$

$$P_{R3} = (I_{C3})^2 R_3$$

$$= \left(I_{B2} + \frac{V_{BE2}}{R_2} \right)^2 R_3$$

$$= \left(2.92 \text{ mA} + \frac{.9}{5K} \right)^2 (9K)$$

$$P_{R3_N} = 20 \text{ mW}$$

$$P_{R4_N} = \frac{(V_{U1} - V_{BE3})^2}{R_4}$$

$$= \frac{(10 - .65)^2}{30K}$$

$$P_{R4_N} = 2.9 \text{ mW}$$

Worst case

$$P_{R1} = (57 \text{ mA})^2 (5.12)$$

$$P_{R1_{wc}} = 16.8 \text{ mW}$$

$$P_{R2_{wc}} = \frac{(.9)^2}{2K - 5.8\%}$$

$$P_{R2_{wc}} = .5 \text{ mW}$$

$$P_{R3} = \left(2.91 \text{ mA} + \frac{1}{5K - 5.8\%} \right)^2 (9K + 4.2\%)$$

$$P_{R3_{wc}} = 91 \text{ mW}$$

$$P_{R4_{wc}} = \frac{(10.5 - .9)^2}{30K - 5.8\%}$$

$$P_{R4_{wc}} = 3.26 \text{ mW}$$

3.5 mW at 125°C

Nominal

$$PR_{5N} = \frac{(V_0 - 10V - V_{BE5})^2}{R_5}$$

$$= \frac{(26.7 - 10V - 0.6)^2}{30K}$$

$$PR_{5N} = 8.6 \text{ mW}$$

$$PR_{6N} = \frac{(V_0)^2}{R_6}$$

$$PR_{6N} = 7.1 \text{ mW}$$

$$PR_7 = \frac{(V_{BE3})^2}{R_7}$$

$$= \frac{(0.65)^2}{15K}$$

$$PR_7 = 0.028 \text{ mW}$$

$$PR_{8N} = \frac{(3.72)^2}{5K}$$

$$PR_{8N} = 2.8 \text{ mW}$$

$$PR_{5wc} = \frac{(29.62 - 5)^2}{30K - 5.8\%}$$

$$PR_{5wc} = 21 \text{ mW} \quad -55^\circ\text{C}$$

$$PR_{6wc} = \frac{(29.62)^2}{100K - 5.8\%}$$

$$PR_{6wc} = 9.3 \text{ mW}$$

$$PR_{7wc} = \frac{(1)^2}{15K - 5.8\%}$$

$$PR_{7wc} = 0.07 \text{ mW}$$

$$PR_{8wc} = \frac{(4.3)^2}{5K - 5.8\%}$$

$$PR_{8wc} = 4 \text{ mW}$$

Power Calculations

(18)

Nom

$$P_{Q1N} = I_{CE0} V_{CE} \\ \approx .1 \text{ mW}$$

Worst case

$$P_{Q1wc} = 10 \mu A 30V \\ P_{Q1wc} = .3 \text{ mW}$$

$$P_{Q2N} = I_{C2} V_{CE} + I_{B2} V_{BE} \\ = 50.87 \text{ m} (.1) + (2.82 \text{ m}) (.9)$$

$$P_{Q2N} = 7.4 \text{ mW}$$

$$P_{Q2wc} = 57 \text{ m} (.2) + 2.91 \text{ m} (.1)$$

$$P_{Q2wc} = 14.3 \text{ mW}$$

$$P_{Q3N} = I_{C3} V_{CE} + I_{B3} V_{BE} \\ = 2.47 \text{ m} (.1) + .269 \text{ m} (.65)$$

$$P_{Q3N} = .47 \text{ mW}$$

$$P_{Q3wc} = 3.535 \text{ m} (.2) + .336 \text{ m} (.1)$$

$$P_{Q3wc} = 1 \text{ mW}$$

$$P_{Q4N} = 0$$

$$P_{Q4wc} = .1 \mu A 10V \\ = 1 \mu W$$

$$P_{Q5N} = V_{CE} I_E + V_{CE} I_C \\ = .6 (1 \text{ m}) + (.8) (.5 \text{ m})$$

$$P_{Q5N} = 1 \text{ mW}$$

$$P_{Q5wc} = 14 (1 \text{ m}) + 10 (.5 \text{ m})$$

$$P_{Q5wc} = 1.5 \text{ mW}$$

$$P_{Q21N} = V_{BE} I_B + V_{CE} I_C \\ = (.65) (.673 \text{ m}) + (.1) (.3 \text{ m})$$

$$P_{Q21N} = .7 \text{ mW}$$

$$P_{Q21wc} = (.1) (.672 \text{ m}) + (.2) (.35 \text{ m})$$

$$P_{Q21wc} = 1.4 \text{ mW}$$

ORIGINAL PAGE IS
OF POOR QUALITY

Nom

$$P_{R3N} = \frac{(V_{u3} - V_{BE2})^2}{R_{33}}$$

$$= \frac{(10 - 0.65)^2}{15k}$$

$$P_{R3N} = 5.8 \text{ mW}$$

$$P_{CR1N} = I_{C2} V_D$$

$$= 57.87 \text{ m}(6)$$

$$P_{CR1N} = 30 \text{ mW}$$

$$P_{CR2} = 0$$

$$P_{CR3N} = \frac{2.6}{35k}$$

$$P_{CR3N} = .4 \text{ mW}$$

$$P_{U1} \approx 2.1 \text{ mW}$$

$$P_{U2} \approx 2.1 \text{ mW}$$

$$P_{U3} \approx .8 \text{ mW}$$

worst case

$$P_{R3wc} = \frac{(10.5 - 1)^2}{15k - 5.8\%$$

$$P_{R3wc} = 6.4 \text{ mW} \quad -55^\circ\text{C}$$

$$= 7 \text{ mW} \quad +125^\circ\text{C}$$

$$P_{CR1wc} = 55 \text{ m}(1)$$

$$P_{CR1wc} = 55 \text{ mW} \quad \text{at } -55^\circ\text{C}$$

$$= 55 \text{ m}(1.5) \quad \text{at } 125^\circ\text{C}$$

$$= 82.5 \text{ mW}$$

$$P_{CR2wc} = I_R V_{BE1}$$

$$= 1 \text{ m} \div (1)$$

$$P_{CR2wc} = 1 \text{ mW}$$

$$P_{CR3wc} = \frac{2.6}{35k - 5.8\%}$$

$$P_{CR3wc} = .9 \text{ mW}$$

Device	Nominal		Worst case	
	PWR/Device	Power	PWR/Device	Power
R1 (5R)	14 mW	18 mW	16.8 mW	67.2 mW
R2 (5K)	.128 mW	.256 mW	.212 mW	.848 mW
R3 (9K)	80 mW	160 mW	91 mW	364 mW
R4 (30K)	2.9 mW	5.8 mW	3.26 mW	13.04 mW
R5 (30K)	8.6 mW	17.2 mW	21 mW	84 mW
R6 (100K)	7.1 mW	14.2 mW	9.6 mW	38.4 mW
R7 (15K)	.029 mW	.056 mW	.07 mW	.28 mW
R8 (5K)	2.8 mW	5.6 mW	4 mW	16 mW
R33 (5K)	5.8 mW	5.8 mW		6.4 mW
Q1 (3906)	.1 mW	.2 mW	.3 mW	1.2 mW
Q2 (4033)	7.5 mW	15 mW	14.8 mW	57.2 mW
Q3 (2222A)	.47 mW	.94 mW	1 mW	4 mW
Q4 (3822)			1 mW	4 mW
Q5 (2945A)				
Q21 (2222A)	.7 mW	.7 mW	1.4 mW	1.4 mW
CR1 (914)	30 mW	60 mW	55 mW	220 mW
CR2 (914)			1 mW	4 mW
CR3 (914)	.4 mW	.8 mW	.9 mW	3.6 mW
U1		2.1 mW		2.1 mW
U2		2.1 mW		2.1 mW
U3		.9 mW		.8 mW

Total Nominal Power 310 mW

Total worst case power 293 mW

with 2 outputs high, 2 low
and B1e enable low

with all outputs
high at worst case
and B1e enable
Low

Case temp Calc

(21)

Calculated using CR1 as hottest device
for $T_J \leq 125^\circ\text{C}$

$$T_J = +Q_{js} \cdot P_J + Q_{sc} P_s + T_c$$

$$T_c \leq -300 (27m) - 13.5 (904m) + 125^\circ\text{C}$$

$$T_c \leq 105^\circ\text{C} \text{ to keep junction temp below } 125^\circ\text{C}$$

for $T_J \leq 150^\circ\text{C}$

$$T_c \leq 130^\circ\text{C} \text{ to keep junction temp below } 150^\circ\text{C}$$

Burn-in temp calculation

(72)

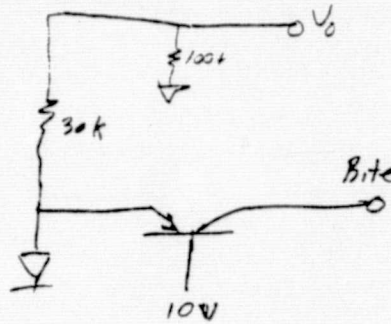
using C1 as hottest device (27 mW) at 175°C

$$T_j = Q_{js} P_j + Q_{sc} P_s + Q_{ca} P_{dr} + T_A$$

$$T_A \leq -300 \cdot (27 \text{ m}) - 13.5 (883 \text{ m}) - 50 (883 \text{ m})$$

$$T_A \leq 85.8$$

use 85° for burn in



$$I_{Bite} = \alpha \left[\frac{V_0 - 10V \pm .1V - V_{BE} - V_0}{30k (1.05)} \right]$$

$$= \alpha \left[\frac{27.5 - 10.1 - 1.5}{31.5k} \right]$$

$$I_{Bite} = \alpha [.41mA]$$

$$\alpha = \frac{\beta}{1+\beta} \approx \frac{18}{19} \text{ at } -55^\circ C$$

$$\alpha = .94$$

$$I_{Bite\ max} = .94 (.41mA)$$

$$I_{Bite\ max} = .38mA$$

across a $10k$ resistor with V_0 at:

$$V_{Bite\ min} = .38mA (10k) \\ = 3.8V$$

C1 pf	C2 pf	t _r ms	t _f ms
560	1000	35	45
560	560	24	40
270	560	17	23
1000	560	30	65
1000	1000	45	70
1500	1000	65	90

Lab analysis of

(24)

Rise & fall times

using different values

of C1 & C2 to represent

worst case conditions

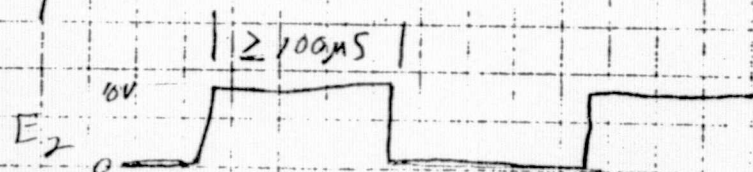
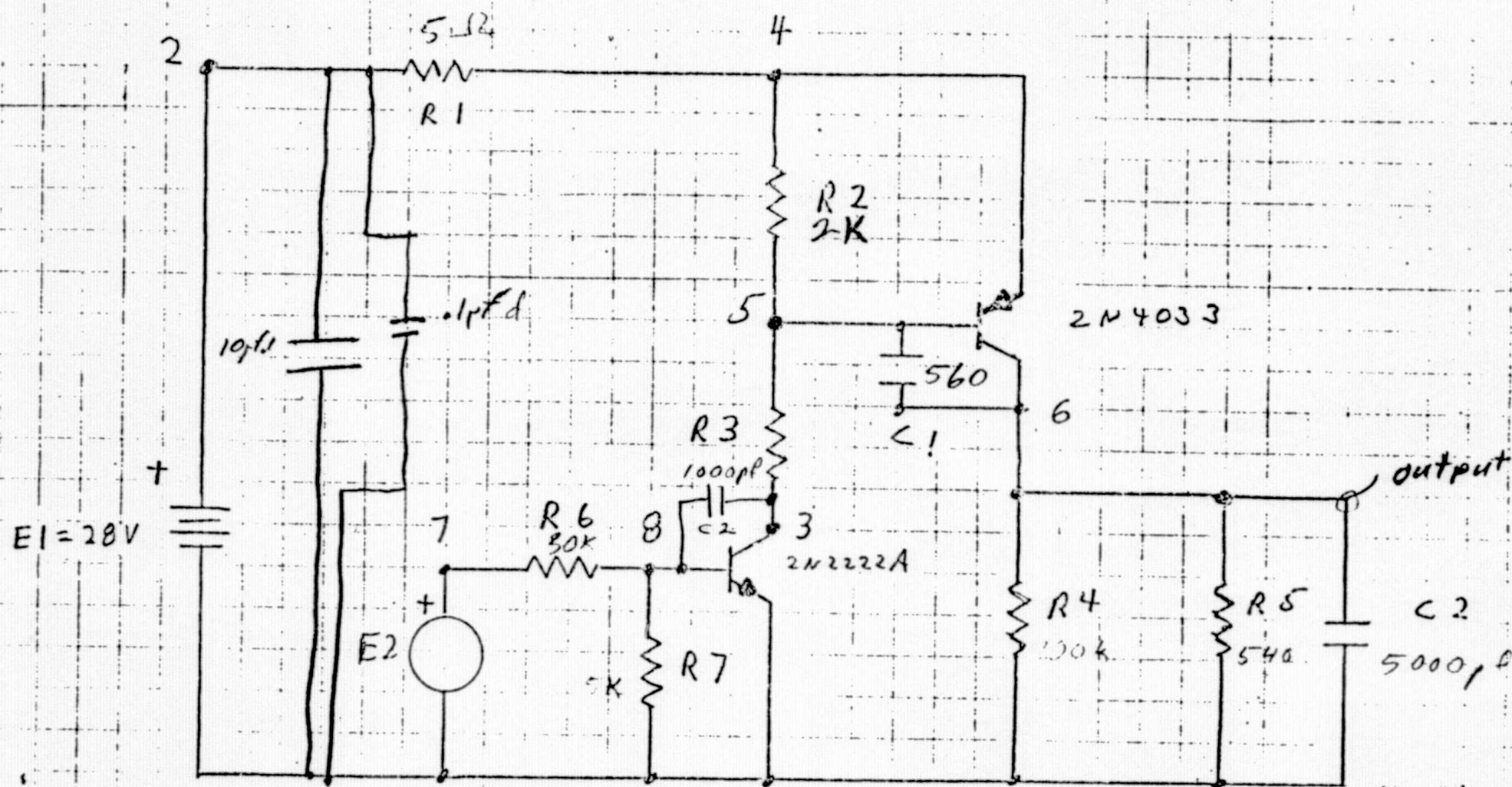
Nominal values are C1 = 560 pf

C2 = 1000 pf

these rise & fall times are for Load conditions shown in Lab circuit model only.

$$t_r = 35 \mu s$$

$$t_A = 45 \mu s$$



CIRCUIT MODEL

Lab

ORIGINAL PAGE IS
OF POOR QUALITY

(25)

Max Stress:

(26)

$$\text{Max } T_J = 175^\circ\text{C at } T_C = 105^\circ\text{C}$$

V stress

$$\text{ICs} \quad \frac{10}{15} = 66\%$$

$$\text{Trans} \quad \frac{1}{5} = 20\%$$

$$\text{Diodes} \quad \frac{28}{100} = 28\%$$

$$\text{Cap} \quad \frac{32}{100} = 32\%$$

$$\text{Resistor} \quad \frac{31}{50} = 62\%$$

$$\text{Current stress} \quad \frac{54\text{mA}}{1\text{A}} = 5.4\%$$

$$\text{Diodes} \quad \frac{54\text{mA}}{83\text{mA}} = 65\%$$

$$\text{Bonding wire} \quad 210\text{ mF}$$

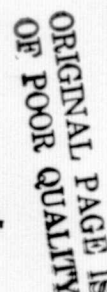
$$20\%$$

APPENDIX III

SCHEMATIC, HYBRID SUBSTRATE AND HYBRID

ASSEMBLY DRAWINGS -

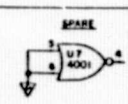
D028 CONTROL 3A



REDUCED SIZE
DO NOT SCALE

REF	SPEERY	REF	SPEERY
PART	NO.	PART	NO.
C#1	2500973-1-01	Q12	2500532-1
C#2	2500973-1-01	Q13	2500513-1
C#3	2500973-1-01		
C#4	2500973-1-01		
C#5	2500973-1-01		
C#6	2500973-1-01		
C#7	2500973-1-01	U#1	2500260-5
C#8	2500973-1-01	U#2	2500260-5
C#9	2500973-1-01	U#3	2500261-1
C#10	2500973-1-01	U#4	2500261-1
		U#5	2500261-1
		U#6	2500261-1
		U#7	2500261-1
		U#8	2500261-1
		U#9	2500261-1
		U#10	2500261-1
Q#1	2500973-1		
Q#2	2500973-1		
Q#3	2500973-1		
Q#4	2500973-1		
Q#5	2500973-1		
Q#6	2500973-1		
Q#7	2500973-1		
Q#8	2500973-1		
Q#9	2500973-1		
Q#10	2500973-1		
Q#11	2500973-1		
Q#12	2500973-1		
Q#13	2500973-1		
Q#14	2500973-1		
Q#15	2500973-1		
Q#16	2500973-1		
Q#17	2500973-1		
Q#18	2500973-1		
Q#19	2500973-1		
Q#20	2500973-1		
Q#21	2500973-1		
Q#22	2500973-1		
Q#23	2500973-1		
Q#24	2500973-1		
Q#25	2500973-1		
Q#26	2500973-1		
Q#27	2500973-1		
Q#28	2500973-1		
Q#29	2500973-1		
Q#30	2500973-1		
Q#31	2500973-1		
Q#32	2500973-1		
Q#33	2500973-1		
Q#34	2500973-1		
Q#35	2500973-1		
Q#36	2500973-1		
Q#37	2500973-1		
Q#38	2500973-1		
Q#39	2500973-1		
Q#40	2500973-1		
Q#41	2500973-1		
Q#42	2500973-1		
Q#43	2500973-1		
Q#44	2500973-1		
Q#45	2500973-1		
Q#46	2500973-1		
Q#47	2500973-1		
Q#48	2500973-1		
Q#49	2500973-1		
Q#50	2500973-1		
Q#51	2500973-1		
Q#52	2500973-1		
Q#53	2500973-1		
Q#54	2500973-1		
Q#55	2500973-1		
Q#56	2500973-1		
Q#57	2500973-1		
Q#58	2500973-1		
Q#59	2500973-1		
Q#60	2500973-1		
Q#61	2500973-1		
Q#62	2500973-1		
Q#63	2500973-1		
Q#64	2500973-1		
Q#65	2500973-1		
Q#66	2500973-1		
Q#67	2500973-1		
Q#68	2500973-1		
Q#69	2500973-1		
Q#70	2500973-1		
Q#71	2500973-1		
Q#72	2500973-1		
Q#73	2500973-1		
Q#74	2500973-1		
Q#75	2500973-1		
Q#76	2500973-1		
Q#77	2500973-1		
Q#78	2500973-1		
Q#79	2500973-1		
Q#80	2500973-1		
Q#81	2500973-1		
Q#82	2500973-1		
Q#83	2500973-1		
Q#84	2500973-1		
Q#85	2500973-1		
Q#86	2500973-1		
Q#87	2500973-1		
Q#88	2500973-1		
Q#89	2500973-1		
Q#90	2500973-1		
Q#91	2500973-1		
Q#92	2500973-1		
Q#93	2500973-1		
Q#94	2500973-1		
Q#95	2500973-1		
Q#96	2500973-1		
Q#97	2500973-1		
Q#98	2500973-1		
Q#99	2500973-1		
Q#100	2500973-1		
Q#101	2500973-1		
Q#102	2500973-1		
Q#103	2500973-1		
Q#104	2500973-1		
Q#105	2500973-1		
Q#106	2500973-1		
Q#107	2500973-1		
Q#108	2500973-1		
Q#109	2500973-1		
Q#110	2500973-1		
Q#111	2500973-1		
Q#112	2500973-1		
Q#113	2500973-1		
Q#114	2500973-1		
Q#115	2500973-1		
Q#116	2500973-1		
Q#117	2500973-1		
Q#118	2500973-1		
Q#119	2500973-1		
Q#120	2500973-1		
Q#121	2500973-1		
Q#122	2500973-1		
Q#123	2500973-1		
Q#124	2500973-1		
Q#125	2500973-1		
Q#126	2500973-1		
Q#127	2500973-1		
Q#128	2500973-1		
Q#129	2500973-1		
Q#130	2500973-1		
Q#131	2500973-1		
Q#132	2500973-1		
Q#133	2500973-1		
Q#134	2500973-1		
Q#135	2500973-1		
Q#136	2500973-1		
Q#137	2500973-1		
Q#138	2500973-1		
Q#139	2500973-1		
Q#140	2500973-1		
Q#141	2500973-1		
Q#142	2500973-1		
Q#143	2500973-1		
Q#144	2500973-1		
Q#145	2500973-1		
Q#146	2500973-1		
Q#147	2500973-1		
Q#148	2500973-1		
Q#149	2500973-1		
Q#150	2500973-1		
Q#151	2500973-1		
Q#152	2500973-1		
Q#153	2500973-1		
Q#154	2500973-1		
Q#155	2500973-1		
Q#156	2500973-1		
Q#157	2500973-1		
Q#158	2500973-1		
Q#159	2500973-1		
Q#160	2500973-1		
Q#161	2500973-1		
Q#162	2500973-1		
Q#163	2500973-1		
Q#164	2500973-1		
Q#165	2500973-1		
Q#166	2500973-1		
Q#167	2500973-1		
Q#168	2500973-1		
Q#169	2500973-1		
Q#170	2500973-1		
Q#171	2500973-1		
Q#172	2500973-1		
Q#173	2500973-1		
Q#174	2500973-1		
Q#175	2500973-1		
Q#176	2500973-1		
Q#177	2500973-1		
Q#178	2500973-1		
Q#179	2500973-1		
Q#180	2500973-1		
Q#181	2500973-1		
Q#182	2500973-1		
Q#183	2500973-1		
Q#184	2500973-1		
Q#185	2500973-1		
Q#186	2500973-1		
Q#187	2500973-1		
Q#188	2500973-1		
Q#189	2500973-1		
Q#190	2500973-1		
Q#191	2500973-1		
Q#192	2500973-1		
Q#193	2500973-1		
Q#194	2500973-1		
Q#195	2500973-1		
Q#196	2500973-1		
Q#197	2500973-1		
Q#198	2500973-1		
Q#199	2500973-1		
Q#200	2500973-1		
Q#201	2500973-1		
Q#202	2500973-1		
Q#203	2500973-1		
Q#204	2500973-1		
Q#205	2500973-1		
Q#206	2500973-1		
Q#207	2500973-1		
Q#208	2500973-1		
Q#209	2500973-1		
Q#210	2500973-1		
Q#211	2500973-1		
Q#212	2500973-1		
Q#213	2500973-1		
Q#214	2500973-1		
Q#215	2500973-1		
Q#216	2500973-1		
Q#217	2500973-1		
Q#218	2500973-1		
Q#219	2500973-1		
Q#220	2500973-1		
Q#221	2500973-1		
Q#222	2500973-1		
Q#223	2500973-1		
Q#224	2500973-1		
Q#225	2500973-1		
Q#226	2500973-1		
Q#227	2500973-1		
Q#228	2500973-1		
Q#229	2500973-1		
Q#230	2500973-1		
Q#231	2500973-1		
Q#232	2500973-1		
Q#233	2500973-1		
Q#234	2500973-1		
Q#235	2500973-1		
Q#236	2500973-1		
Q#237	2500973-1		
Q#238	2500973-1		
Q#239	2500973-1		
Q#240	2500973-1		
Q#241	2500973-1		
Q#242	2500973-1		
Q#243	2500973-1		
Q#244	2500973-1		
Q#245	2500973-1		
Q#246	2500973-1		
Q#247	2500973-1		
Q#248	2500973-1		
Q#249	2500973-1		
Q#250	2500973-1		
Q#251	2500973-1		
Q#252	2500973-1		
Q#253	2500973-1		
Q#254	2500973-1		
Q#255	2500973-1		
Q#256	2500973-1		
Q#257	2500973-1		
Q#258	2500973-1		
Q#259	2500973-1		
Q#260	2500973-1		
Q#261	2500973-1		
Q#262	2500973-1		
Q#263	2500973-1		
Q#264	2500973-1		
Q#265	2500973-1		
Q#266	2500973-1		
Q#267	2500973-1		
Q#268	2500973-1		
Q#269	2500973-1		
Q#270	2500973-1		
Q#271	2500973-1		
Q#272	2500973-1		
Q#273	2500973-1		
Q#274	2500973-1		
Q#275	2500973-1		
Q#276	2500973-1		
Q#277	2500973-1		
Q#278	2500973-1		
Q#279	2500973-1		
Q#280	2500973-1		
Q#281	2500973-1		
Q#282	2500973-1		
Q#283	2500973-1		
Q#284	2500973-1		
Q#285	2500973-1		
Q#286	2500973-1		
Q#287	2500973-1		
Q#288	2500973-1		
Q#289	2500973-1		
Q#290	2500973-1		
Q#291	2500973-1		
Q#292	2500973-1		
Q#293	2500973-1		
Q#294	2500973-1		
Q#295	2500973-1		
Q#296	2500973-1		
Q#297	2500973-1		
Q#298	2500973-1		
Q#299	2500973-1		
Q#300	2500973-1		
Q#301	2500973-1		
Q#302	2500973-1		
Q#303	2500973-1		
Q#304	2500973-1		
Q#305	2500973-1		
Q#306	2500973-1		
Q#307	2500973-1		
Q#308	2500973-1		
Q#309	2500973-1		
Q#310	2500973-1		
Q#311	2500973-1		
Q#312	2500973-1		
Q#313	2500973-1		
Q#314	2500973-1		
Q#315	2500973-1		
Q#316	2500973-1		
Q#317	2500973-1		
Q#318	2500973-1		
Q#319	2500973-1		
Q#320	2500973-1		
Q#321	2500973-1		
Q#322	2500973-1		
Q#323	2500973-1		
Q#324	2500973-1		
Q#325	2500973-1		
Q#326	2500973-1		
Q#327	2500973-1		
Q#328</			

- NOTES:**
- UNLESS OTHERWISE SPECIFIED:
- 1 ALL CAPACITANCE VALUES ARE IN MICROFARADS.
 - 2 ALL RESISTANCE VALUES ARE IN OHMS.
 - 3 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN FOR COMPLETE DESIGNATIONS PREFIX PART DESIGNATIONS WITH RUDESKIN'S DESIGNATION.
 - 4 INTERMATT DRAWING PER ANSI Y32-1975 AND Y32-16-1973.
 - 5 PTP RECTIFIER 1-POLYMERISE SEE 402E/5B-BOL.
- WE THINK WE AND YOU THINK USING PIN 14 IS +V_{CC}, PIN 7 IS GND.
- WE THINK WE AND YOU THINK USING PIN 14 IS GND, PIN 7 IS +V_{CC}, PIN 18 IS GND.
- WE PIN 1 IS +V_{CC}, PIN 7 IS 18 GND.

[illegible]

SPERRY DESIGN REF
DPA NO. D-21907
PROD. LINE NO. 8191-49
AW/PS ANALYSIS EB 4032504

DWG NO. 4026159

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE
FOR REVISION RECORD SEE LAST SHEET			

NOTES:

1. APPLY MARKING AND LOT CODE:

XXXXX LOT LETTER IN
YEAR WEEK GIVEN WEEK

EXAMPLE: 7202B; YEAR, 72, WEEK 02, AND LOT B IN WEEK 02.

2. REFERENCE SPECIFICATIONS:

MANUFACTURE AND MARKING PER ITEM 701
TESTING PER ITEM 702

3. UNLESS OTHERWISE SPECIFIED:

ALL RESISTANCE VALUES ARE GIVEN IN OHMS.
ALL CAPACITANCE VALUES ARE GIVEN IN PICO FARADS.
COMPONENT AND PIN DESIGNATIONS AND SEMICONDUCTOR
DEVICE TYPE NUMBERS NOTED ARE FOR REFERENCE ONLY.

4. SYMBOLS:

/□ = DENOTES "PER SQUARE".
▲ = INDICATES PROBE AREA.

5. IDENTIFICATION CODE:

- ☐ FIRST CONDUCTOR LAYER (AU)
- ☒ SECOND CONDUCTOR LAYER (AU)
- ☒ THIRD CONDUCTOR LAYER (AU)
- ☐ RX RESISTORS
- ☐ GLASS OVERGLAZE
- ☐ CROSSOVER DIELECTRIC GLASS

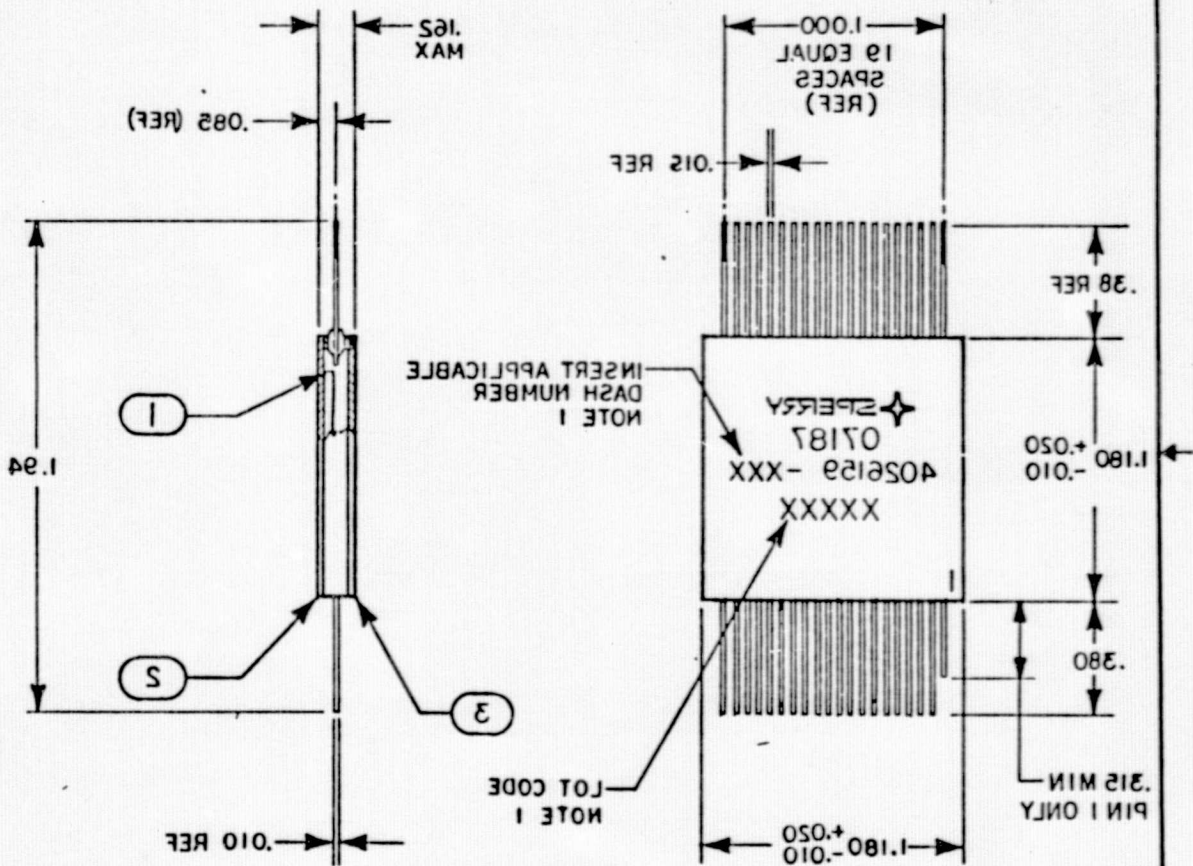
ORIGINAL PAGE IS
OF POOR QUALITY

REV STATUS OF PARTS LIST SHALL BE SAME AS
BASIC DRAWING NUMBER
SEE SEPARATE PARTS LIST

MFG REF. NO.		THIRD ANGLE PROJECTION		INTERPRET DIM AND TOL PER ANSI Y14.5-1986 UNLESS OTHERWISE SPECIFIED DIM ARE IN INCHES.		CONTRACT		24 23 22 21 20 19 18 17 16 15 14 13 SHEET		REV	
SPERRY ITEM CODE - SEE EB 699384		BCDEFH		TOLERANCES: ANGLES ± — SPL DEC ± .02 SPL DEC ± .005		NAS9-15359		12 11 10 9 8 7 6 5 4 3 2 1 SHEET		REV	
SPERRY SPEC REFERENCED		OPERATIONAL NOTE		REFERENCE DRAWINGS		DRAWN BY DATE					
		VARIABLE ASSY				CHECKED BY DATE					
MATERIAL		MILITARY DESIGNATION		SPERRY REG-MATL, PROCESS, FIN. SEE GO. NO.		APPROVED FOR MFG DATE					
						APPROVED FOR SPERRY DATE					
PROCESS						APPROVED FOR SPERRY DATE					
4032521-901						APPROVED FOR SPERRY DATE					
NEXT ASSY		USED ON		FIN.		SPERRY CLASS					
						A					
APPLICATION						FIRST USED ON					
						4032521-901					

TITLE		SIZE	CODE IDENT NO.	DRAWING NO.	REV.
MICROCIRCUIT -		B	07187	4026159	-
DO28 CONTROL 3A		SCALE	UNIT WT.	SHEET	OF 9

ZONE	CTR	DESCRIPTION	DATE	APPROVED



REV	-	SCALE	5:1	SHEET	5
DRAWING NO.	4050129	CODE IDENT NO.	07187	SIZE	B

ORIGINAL PAGE IS
OF POOR QUALITY

COMPONENT INFORMATION									
ITEM	REF DES	VALUE	TOL	MAX	MIN	FORM	POWER		TEMP COEF OF RES
							PD	RATING	
8	R1	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W	137.5MW	+150 PPM/°C
10	R2	10K	±5%	10.5K	9.5K	10K (1)	100W		+100
8	R3	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
10	R4	10K	±5%	10.5K	9.5K	10K (1)	100W		+100
8	R5	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
10	R6	10K	±5%	10.5K	9.5K	10K (1)	100W		+100
8	R7	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
9	R8	5K	±5%	5.25K	4.75K	5K (1)	200W		+100
8	R9	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
9	R10	5K	±5%	5.25K	4.75K	5K (1)	200W		+100
8	R11	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
9	R12	5K	±5%	5.25K	4.75K	5K (1)	200W		+100
8	R13	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
9	R14	5K	±5%	5.25K	4.75K	5K (1)	200W		+100
8	R15	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
9	R16	5K	±5%	5.25K	4.75K	5K (1)	200W		+100
8	R17	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
8	R18	500 Ω	±5%	525 Ω	475 Ω	500 (1)	1.65W		+150
10	R19	10K	±5%	10.5K	9.5K	10K (1)	100W		+100
10	R20	10K	±5%	10.5K	9.5K	10K (1)	100W		+100
9	R21	5K	±5%	5.25K	4.75K	5K (1)	200W	137.5MW	+100
9	R22	5K	±5%	5.25K	4.75K	5K (1)	100W	27.5W	+150
11	R23	50K	±5%	52.5K	47.5K	50K (1)	200W	268.75MW	+100
10	R24	5K	±5%	5.25K	4.75K	5K (1)	100W	217.5MW	+100
11	R25	50K	±5%	52.5K	47.5K	50K (1)	200W	268.75MW	+100
10	R26	10K	±5%	10.5K	9.5K	10K (1)	100W	167.5MW	+100
9	R27	5K	±5%	5.25K	4.75K	5K (1)	100W	137.5MW	+100
9	R28	5K	±5%	5.25K	4.75K	5K (1)	500W	137.5MW	+100
11	R29	100K	±2%	100.12K	99.88K	100K (1)	100W	12.5MW	+100
11	R30	100K	±2%	100.12K	99.88K	100K (1)	100W	12.5MW	+100
11	R31	100K	±2%	100.12K	99.88K	100K (1)	100W	12.5MW	+100 PPM/°C
10	R32								
10	R33								
10	R34								
10	R35								
10	R36								
10	R37								
10	R38								
10	R39								
10	R40								

[illegible]

FOR CONTRACT NUMBER
WHEN APPLICABLE,
SEE FIRST SHEET.

SIZE
B
SCALE

FSCM NO.
0718

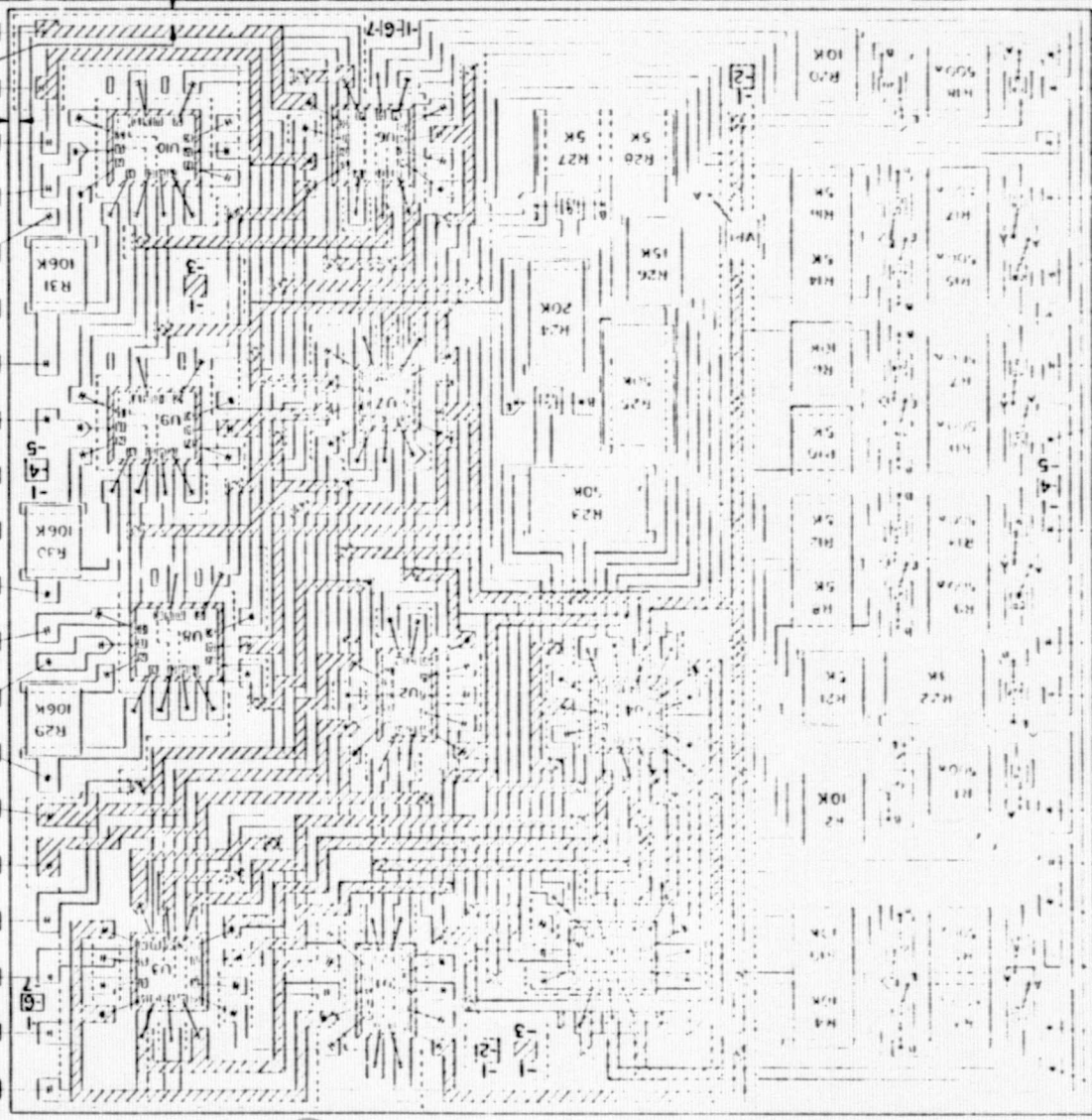
DRAWING NO.
4026159

REV

SHEET 3

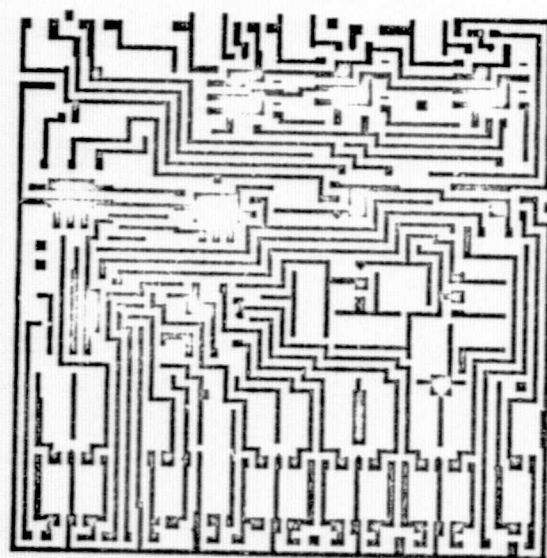
REF	DES	DEVICE	SERIAL NO.
CR1		1N914	2500975-201
CR10			
Q1	2N3906	4007496	
Q2			
Q4	2N3904	4007495	
Q5			
Q10		2N2369	2500360
Q11	2N3906	4007496	
Q12		2N2222A	2501532
Q13		2N2222A	2501532
U1	CD4013AH	4020303	
U2	CD4013AH	4020303	
U3	CD4011AH	4020301	
U4	CD4023AH	4020303	
U5	CD4027AH	4020310	
U6	CD4049AH	4015267	
U7	CD4001AH	4020306	
U8	CD4047AH	4020305	
U9	CD4047AH	4020305	
U10	CD4047AH	4020305	
VR1	5.1V		2500972 212

SIZE	CODE IDENT NO.	SCALE
B	07187	SCALE 4
REV	4026159	SHEET 4

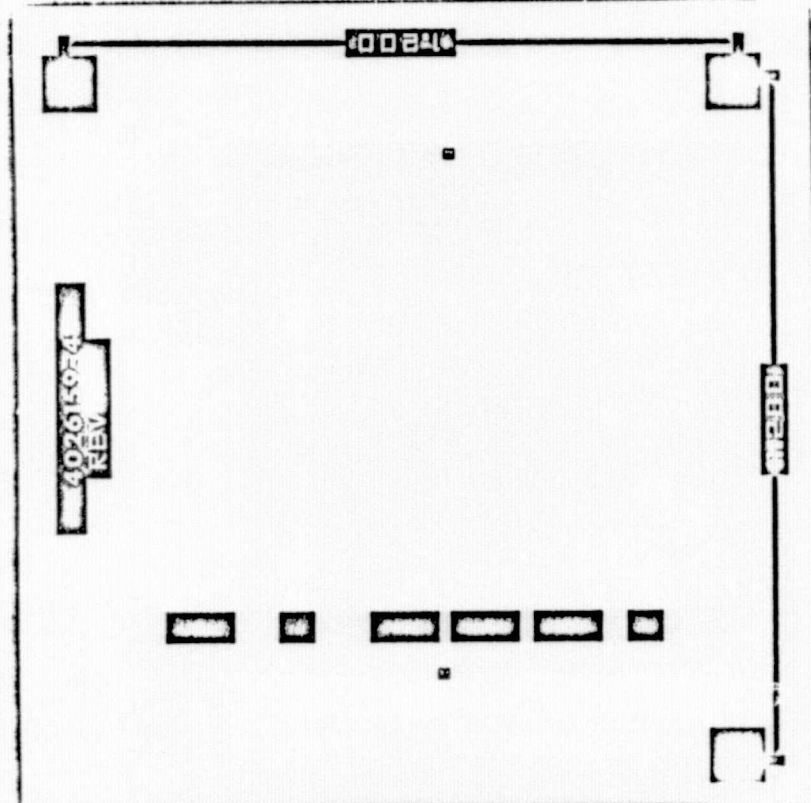
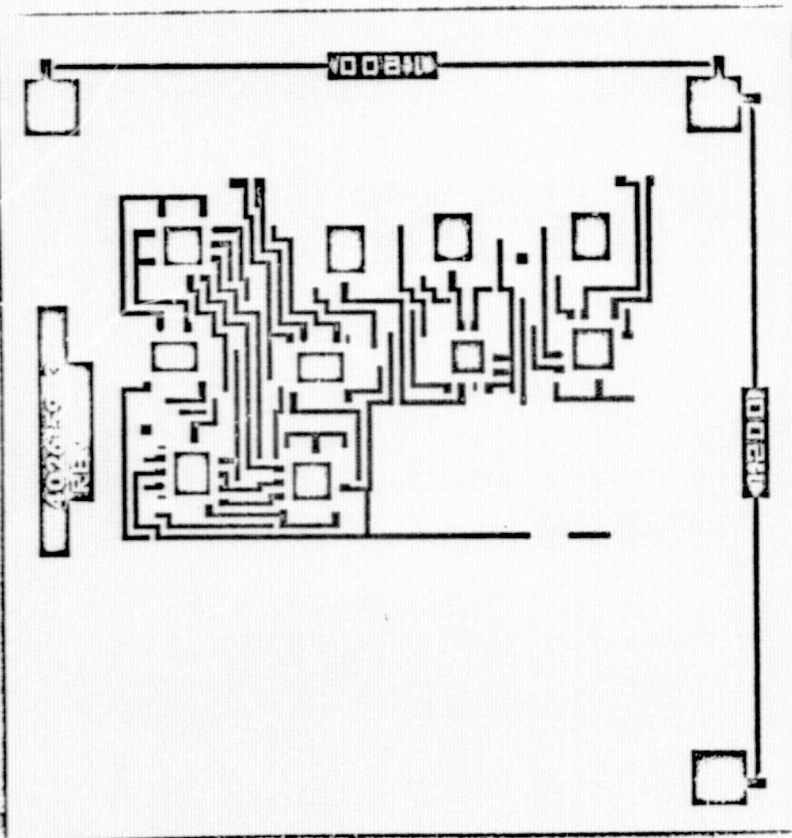


REV	SIZE	CODE IDENT NO.	SCALE
B	07187	SCALE 4	
REV	4026159	SHEET 4	

ORIGINAL PAGE IS
OF POOR QUALITY



SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	07187	4026159	-
SCALE	5/1	SHEET 5	



SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	07187	4026159	-
SCALE 5/1			SHEET 6

ORIGINAL PAGE IS
OF POOR QUALITY

4026159
NEW

4026159
NEW

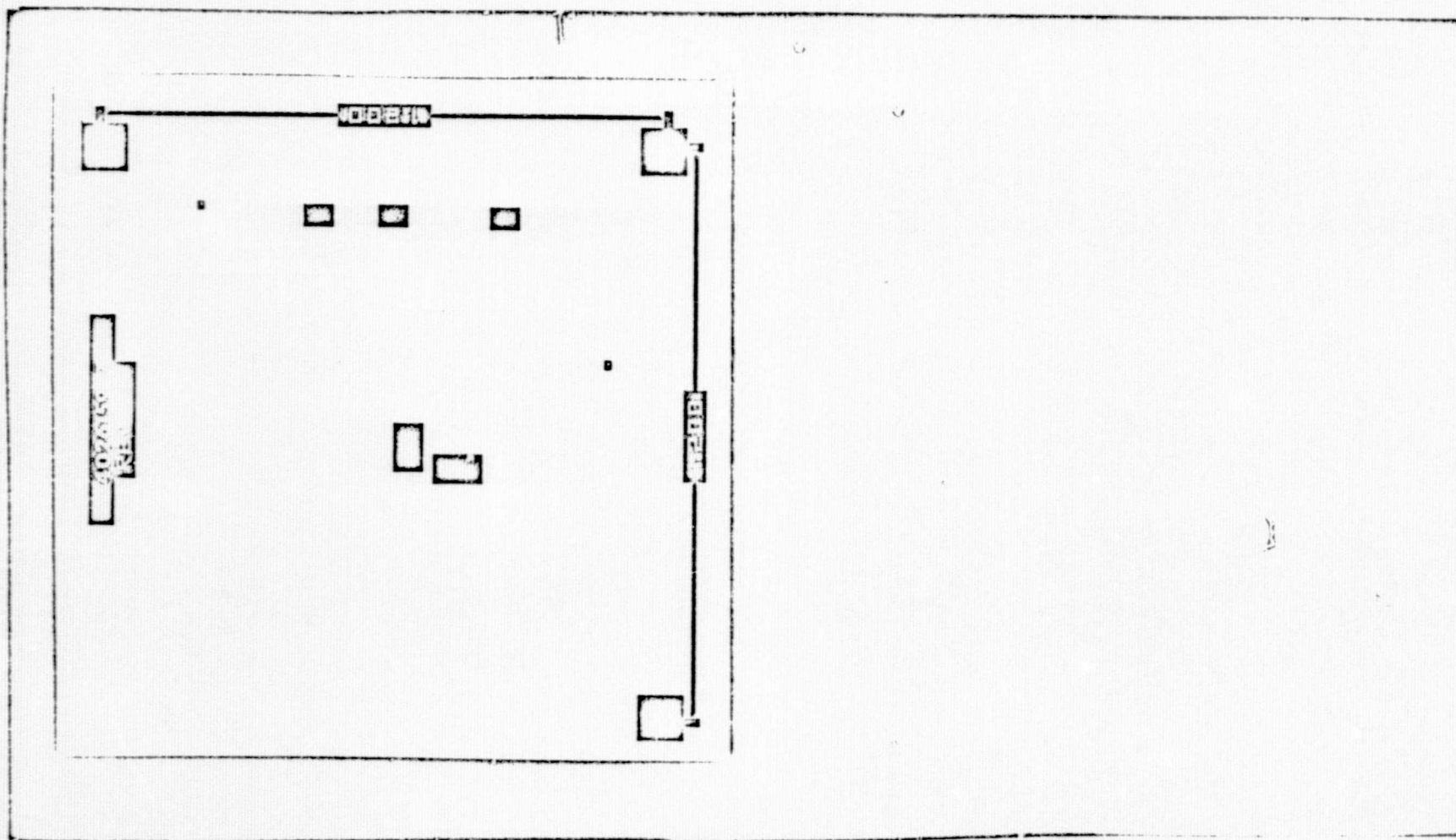
4026159

4026159

4026159

4026159

SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	07187	4026159	-
SCALE 5/1	SHEET 7		



9231-033 (B-72)

SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	07187	4026159	-
SCALE 5/1		SHEET 3	

PARTS LIST		SPERRY FLIGHT SYSTEMS PHOENIX, ARIZONA		PRODUCT ENGINEER D. Mitchell		CONTRACT NO. NAS9-15359		CODE IDENT NO. 07187		DRAWING NO. PL 4026159		REV LTR -					
PART TABULATION				DESIGN CHECKER S. Spears		END ITEM 4032521-901		TITLE MICROCIRCUIT-DO 2A CONTROL 3A		DATE 22 DEC 77		SHEET 1 OF 2					
ITEM NO.	QTY REQ	QTY REQ	QTY REQ	QTY REQ	QTY REQ	QTY REQ	QTY REQ	QTY REQ	QTY REQ	QTY REQ	UNIT OF MEAS	CODE IDENT	SPERRY NUMBER	PART OR IDENTIFYING NUMBER	NOMEN CLATURE	DESCRIPTION	CODE
1		-80	-90									EA	4026159-801	4026159-801	MICROCKT		3
2												EA	4020514	4020514	FRAME		V
3												EA	4020636-10	4020636-10	LID		V
4		1										EA	4019896-10	4019896-10	SBSTR		V
5		X										EA	4026159-1	4026159-1	CNDCT	AU	5
6		X										EA	4026159-2	4026159-2	CNSVR	DIELECTRIC GLASS	5
7		X										EA	4026159-3	4026159-3	CNDCT	AU	5
8		X										EA	4026159-4	4026159-4	RESISTOR	500 OHMS/SQ	5
9		X										EA	4026159-5	4026159-5	RESISTOR	5K/SQ	5
10		X										EA	4026159-6	4026159-6	RESISTOR	10K/SQ	5
11		X										EA	4026159-7	4026159-7	RESISTOR	100K/SQ	5
12			2									EA	4020603	4020603	MICROCKT		V
13			1									EA	4020601	4020601	MICROCKT		V
14			1									EA	4020608	4020608	MICROCKT		V
15			1									EA	4020610	4020610	MICROCKT		V
16			1									EA	4015267	4015267	MICROCKT		V
17			1									EA	4020596	4020596	MICROCKT		V
18			3									EA	4020925	4020925	MICROCKT		V
19			10									EA	2500973-201	2500973-201	DIODE		V
20			2									EA	4007496	4007496	SEMICON		V
21			3									EA	4007495	4007495	SEMICON		V
22			6									EA	2500860	2500860	SWITCH		V
23			2									EA	2501532	2501532	SEMICON		V
24			1									EA	2500972-212	2500972-212	DIODE		V
701		X	X									EA	M4000757-4	M4000757-4	MICROCKT	THICK-FILM-HYBRID	5
702			X									EA	T4033813	T4033813	TESTSPEC		5
703			X									EA	4026160	4026160	SCHEM		5

SPECIAL SYMBOLS

X NO SPECIFIC QTY REQD (QTY TABLE)
 * BASIC PART NUMBER (QTY TABLE)
 A MATERIAL CODE (NOT A DWG)

500 ITEM NO. SERIES FOR AWP'S CRITICAL ITEMS
 700 ITEM NO. SERIES FOR REF DOCUMENTS

CODE LEGEND

1 SELECT AT ASSEMBLY (FIRST SELECT ITEM)
 2 SUBSEQUENT SELECT
 3 ASSEMBLY

4 BULK OR SUNDRY ITEM
 5 REFERENCE DOCUMENT
 7 CASTING (MAKE FROM) MACHINE DWG

8 SELECT PER AG OR MI
 V VENDOR ITEM SPEC/SOURCE DWG
 * CUSTOMER FURNISHED ITEM

NOTE: SEE BASIC DRAWING FOR PROPRIETARY OR DATA RIGHTS NOTATIONS

PARTS LIST REVISION RECORD	 SPERRY FLIGHT SYSTEMS PHOENIX, ARIZONA	PRODUCT ENGINEER D. Mitchell	CONTRACT NO. NAS9-15359	CODE IDENT NO. 07187	DRAWING NO. PL 4026159	REV LTR -	
		DESIGN CHECKER S. Spears	END ITEM 4032521-901	TITLE MICROCIRCUIT-00 28 CONTROL 3A		DATE 22 DEC 77	SHEET 2 OF 2
		SPECIAL DESIGNATION	NEXT ASSY				
REV. LTR.	DESCRIPTION OF REVISIONS					DATE MO DAY YR	APPROVAL
	INITIAL RELEASE					12 22 77	<i>J. Ray</i>
SHEET INDEX		ALL SHEETS OF THIS DOCUMENT BEAR THE SAME REVISION LETTER.					
CAUTION: REVISION STATUS OF PARTS LIST SHALL BE THE SAME AS BASIC DRAWING NUMBER.							
NOTE: SEE BASIC DRAWING FOR PROPRIETARY OR DATA RIGHTS NOTATIONS							

8231 008 (REV 8 78)

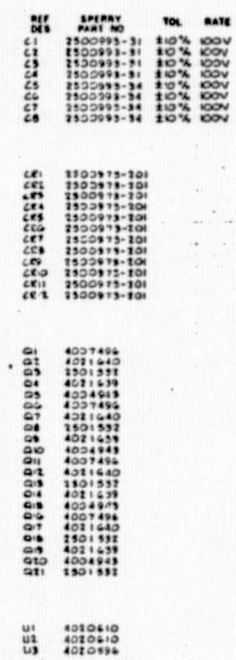
ORIGINAL PAGE IS
OF POOR QUALITY

APPENDIX IV

SCHEMATIC, HYBRID SUBSTRATE AND HYBRID

ASSEMBLY DRAWINGS -

D028 DRIVER 2



REDUCED SIZE
DO NOT SCALE

- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|--|--|--|--|--|--|--|--|---|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|---|--|--|--|--|--|--|--|--|--|
| FORM NO. 104-101 (REV. 1-65)
TABLE OF CONTENTS | | | | | | | | | | PART I
GENERAL INFORMATION | | | | | | | | | | PART II
SPECIFICATIONS | | | | | | | | | | PART III
DRAWINGS | | | | | | | | | | PART IV
NOTES | | | | | | | | | |
| 1. NAME OF THE PROJECT
2. NAME OF THE CONTRACTOR
3. NAME OF THE ARCHITECT
4. NAME OF THE ENGINEER | | | | | | | | | | 5. NAME OF THE OWNER
6. NAME OF THE DESIGNER
7. NAME OF THE CONSULTANT
8. NAME OF THE FABRICATOR | | | | | | | | | | 9. NAME OF THE MANUFACTURER
10. NAME OF THE DISTRIBUTOR
11. NAME OF THE INSTALLER
12. NAME OF THE MAINTAINER | | | | | | | | | | 13. NAME OF THE USER
14. NAME OF THE OPERATOR
15. NAME OF THE MAINTAINER
16. NAME OF THE REPAIRER | | | | | | | | | | 17. NAME OF THE INSPECTOR
18. NAME OF THE APPROVER
19. NAME OF THE REVIEWER
20. NAME OF THE SIGNER | | | | | | | | | |
| 21. NAME OF THE PROJECT
22. NAME OF THE CONTRACTOR
23. NAME OF THE ARCHITECT
24. NAME OF THE ENGINEER | | | | | | | | | | 25. NAME OF THE OWNER
26. NAME OF THE DESIGNER
27. NAME OF THE CONSULTANT
28. NAME OF THE FABRICATOR | | | | | | | | | | 29. NAME OF THE MANUFACTURER
30. NAME OF THE DISTRIBUTOR
31. NAME OF THE INSTALLER
32. NAME OF THE MAINTAINER | | | | | | | | | | 33. NAME OF THE USER
34. NAME OF THE OPERATOR
35. NAME OF THE MAINTAINER
36. NAME OF THE REPAIRER | | | | | | | | | | 37. NAME OF THE INSPECTOR
38. NAME OF THE APPROVER
39. NAME OF THE REVIEWER
40. NAME OF THE SIGNER | | | | | | | | | |

SPERRY DESIGN REF	
DPA NO.	D-21954
PROD. LINE NO.	8191-48
AW/PS ANALYSIS EB	4032504

DWG NO. 4026161

REVISIONS			
ZONE/LTR	DESCRIPTION	DATE	APPROVED
FOR REVISION RECORD SEE LAST SHEET			

NOTES:

1. APPLY MARKING AND LOT CODE:

XXXXXX LOT LETTER IN
YEAR WEEK GIVEN WEEK

EXAMPLE: 7202B; YEAR 72, WEEK 02, AND LOT B IN WEEK 02.

2. REFERENCE SPECIFICATIONS:

MANUFACTURE AND MARKING PER ITEM 701
TESTING PER ITEM 702

3. UNLESS OTHERWISE SPECIFIED:

ALL RESISTANCE VALUES ARE GIVEN IN OHMS.
ALL CAPACITANCE VALUES ARE GIVEN IN PICO FARADS.
COMPONENT AND PIN DESIGNATIONS AND SEMICONDUCTOR
DEVICE TYPE NUMBERS NOTED ARE FOR REFERENCE ONLY.

4. SYMBOLS:

/□ = DENOTES "PER SQUARE".

5. IDENTIFICATION CODE:

☐ FIRST CONDUCTOR LAYER (AU)

☒ SECOND CONDUCTOR LAYER (AU)

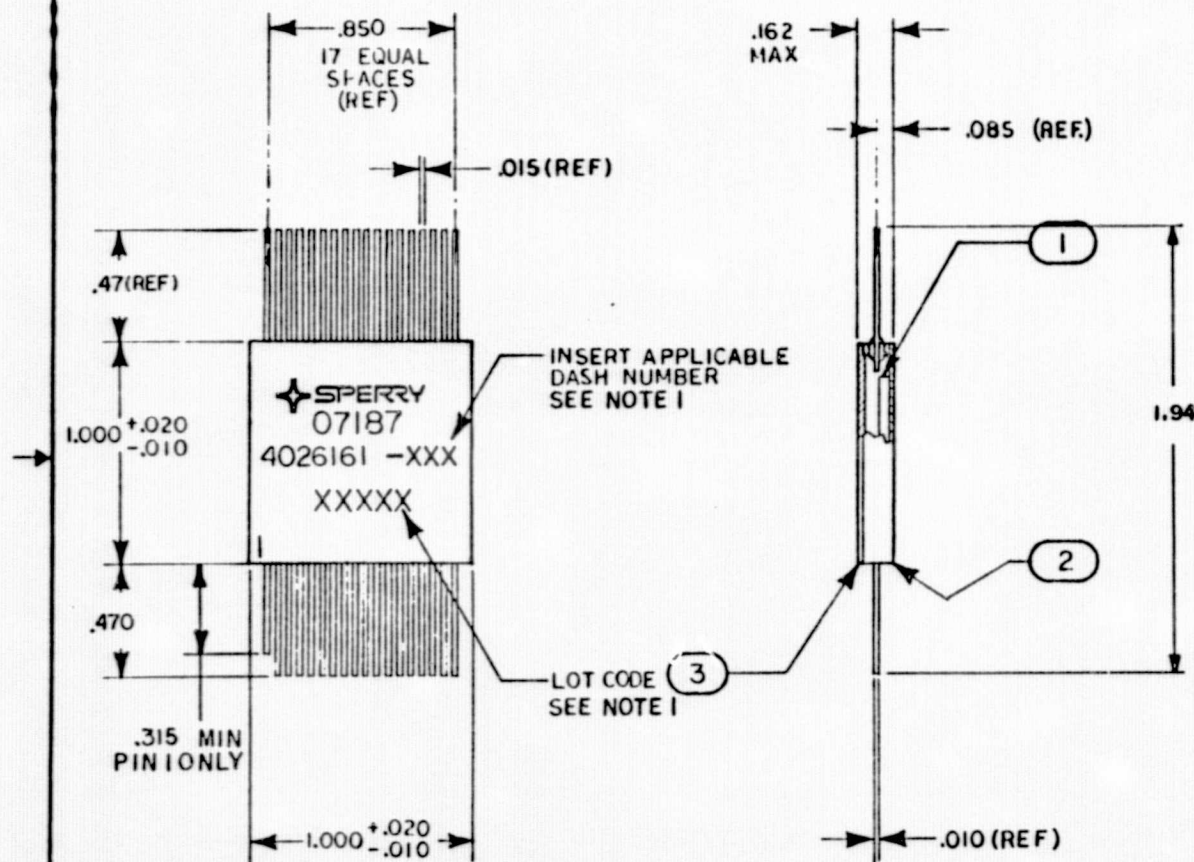
☐ RX RESISTORS

☐ CROSSOVER DIELECTRIC GLASS

REV STATUS OF PARTS LIST SHALL BE SAME AS
BASIC DRAWING NUMBER
SEE SEPARATE PARTS LIST

MFG REF. NO.		THIRD ANGLE PROJECTION		INTERPRET DIM AND TOL PER ANSI Y14.5-1986 UNLESS OTHERWISE SPECIFIED DIM ARE IN INCHES.		CONTRACT NAS9-15359		REV		SHEET	
SPERRY ITEM CODE-SEE EB 699384		B	C	D	E	F	H	DRAWN BY 15 Nov 77		12 11 10 9 8 7 6 5 4 3 2 1 SHEET	
SPERRY SPEC REFERENCED		OPERATIONAL NOTE VARIABLE ASSEMBLY		TOLERANCES: ANGLES ±		ZPL DEC ± 3PL DEC ±		CHECKED BY DATE		REV INDEX	
MATERIAL PROCESS FIN		MILITARY DESIGNATION		SPERRY REQ-MATL, PROCESS, FIN. SEE DD. NO		REFERENCE DRAWINGS		APPROVED FOR MFG/DE DATE 2.6.80 12.9.81		TITLE MICROCIRCUIT - DO 28 DRIVER 2	
MATERIAL								APPROVED FOR SPERRY DATE 2.2.81 28 DEC 77		SIZE B	
PROCESS								APPROVED FOR SPERRY DATE 11/28/77		CODE IDENT NO. 07187	
FIN.								APPROVED FOR DATE		DRAWING NO. 4026161	
NEXT ASSY										UNIT WT.	
APPLICATION										SHEET 1 OF 9	
4032521-901										SCALE NONE	
USED ON										REV -	
										4032521-901	

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE
			APPROVED

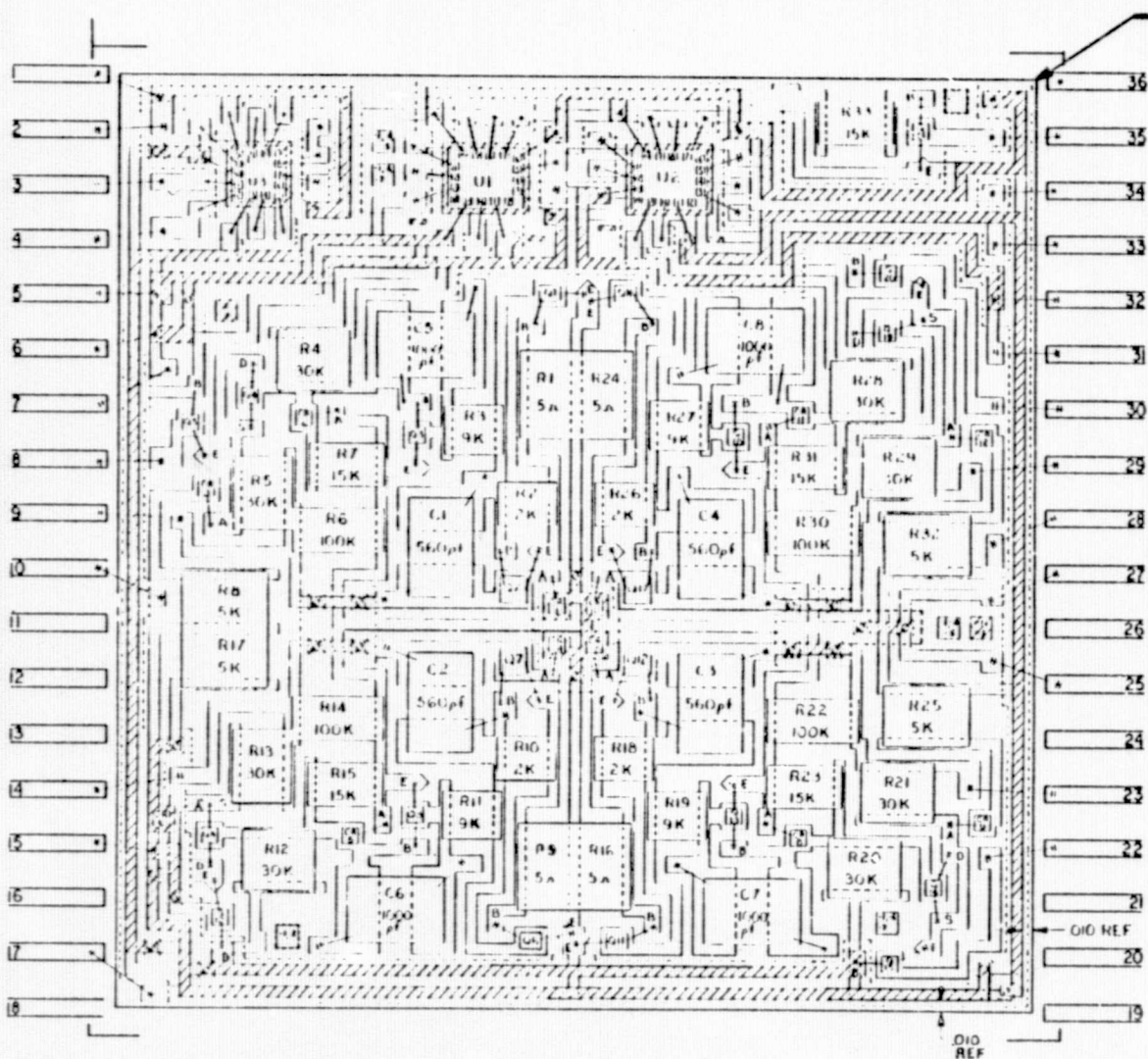


SIZE	CODE IDENT NO.	DRAWING NO.	REV.
B	07187	4026161	-
SCALE 2/1		SHEET 2	

FORM 5231-033(8-73) 10-0188

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY



USE THIS CORNER FOR
ALIGNMENT OF 10K/50
RESISTORS USING
4026161-6 SCREEN, IF
REQUIRED TO ACHIEVE
UNIFORM RESISTOR
VALUES.

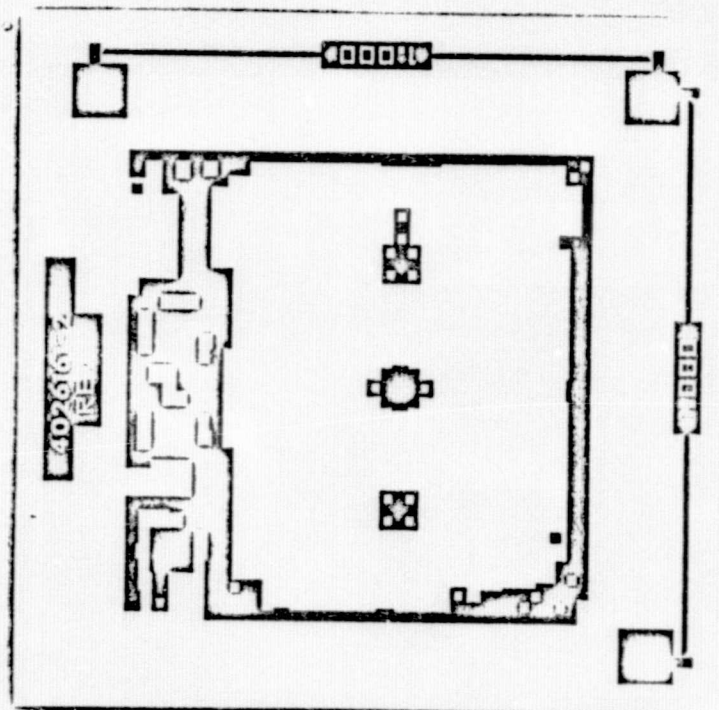
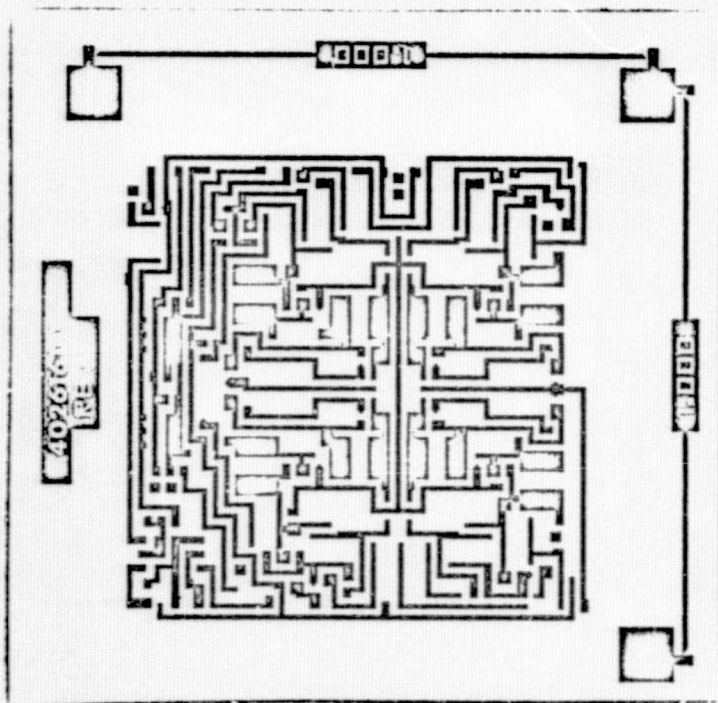
REF DES	DEVICE TYPE	SPERRY PART NO.
C1	560pF /	2500993-031
C4		
C5		
C8	1000pF	2500993-034
CR1	1N914	2500973-201
CR12		
Q1	2N3906	4007496
Q2	2N4033	4021640
Q3	2N2222A	2501532
Q4	2N3822	4021639
Q5	2N2945A	4004943
Q6	2N3906	4007496
Q7	2N4033	4021640
Q8	2N2222A	2501532
Q9	2N3822	4021639
Q10	2N2945A	4004943
Q11	2N3906	4007496
Q12	2N4033	4021640
Q13	2N2222A	2501532
Q14	2N3822	4021639
Q15	2N2945A	4004943
Q16	2N3906	4007496
Q17	2N4033	4021640
Q18	2N2222A	2501532
Q19	2N3822	4021639
Q20	2N2945A	4004943
Q21	2N2222A	2501532
U1	CD4027AH	4020610
U2	CD4027AH	4020610
U3	CD4001AH	4020596

SIZE	CODE IDENT NO	DRAWING NO.	REV
B	07187	4026161	-
SCALE	5/1	SHEET	3

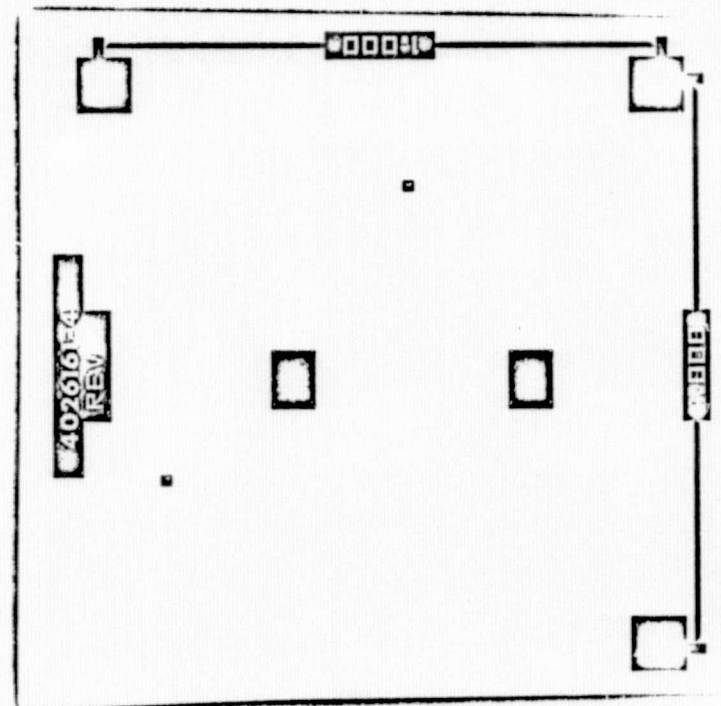
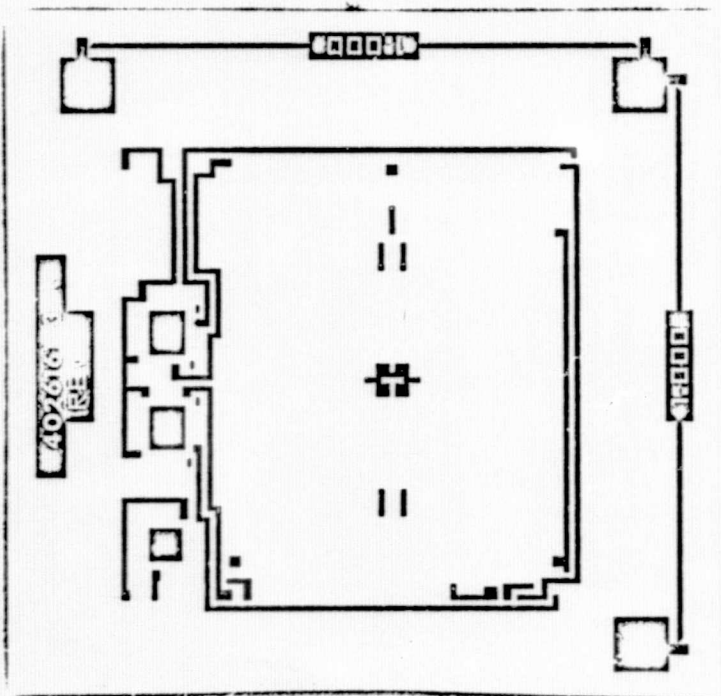
COMPONENT INFORMATION									COMPONENT INFORMATION										
ITEM	REF DES	VALUE	TOL	MAX	MIN	FORM	POWER		TEMP COEF OF RES	ITEM	REF DES	VALUE	TOL	MAX	MIN	FORM	POWER		TEMP COEF OF RES
							Pd	RATING									Pd	RATING	
8	R1	5.1	±10%	5.51	4.51	10 (L)	170W	100W	+200 PPM/°C	16	CR4								
9	R2	2K	±5%	2.1K	1.9K	20 (L)	170W	100W	+100	16	CR5								
10	R3	9K	±2%	8.18K	8.82K	10K (L)	170W	100W	+100	16	CR6								
11	R4	30K	±5%	31.5K	28.5K	50K (L)	3.50W	175W	±100	16	CR7								
11	R5	30K	±5%	31.5K	28.5K	50K (L)	220W	175W	±100	16	CR8								
11	R6	100K	±5%	105K	95K	50K (L)	100W	140W	±100	16	CR9								
10	R7	15K	±5%	15.75K	14.25K	10K (L)	170W	110W	±100	16	CR10								
10	R8	5K	±5%	5.25K	4.75K	10K (L)	40W	100W	±100	16	CR11								
8	R9	5.1	±10%	5.51	4.51	10 (L)	170W	100W	+200	16	CR12								
8	R10	2K	±5%	2.1K	1.9K	20 (L)	170W	100W	+100										
10	R11	9K	±2%	8.18K	8.82K	10K (L)	170W	100W	±100	17	Q1								
11	R12	30K	±5%	31.5K	28.5K	50K (L)	3.50W	175W	±100	18	Q2								
11	R13	30K	±5%	31.5K	28.5K	50K (L)	220W	175W	±100	19	Q3								
11	R14	100K	±5%	105K	95K	50K (L)	100W	140W	±100	20	Q4								
10	R15	15K	±5%	15.75K	14.25K	10K (L)	170W	110W	±100	21	Q5								
8	R16	5.1	±10%	5.51	4.51	10 (L)	170W	100W	+200	17	Q6								
10	R17	5K	±5%	5.25K	4.75K	10K (L)	40W	100W	±100	18	Q7								
8	R18	2K	±5%	2.1K	1.9K	20 (L)	170W	100W	+100	19	Q8								
10	R19	9K	±2%	8.18K	8.82K	10K (L)	170W	100W	±100	20	Q9								
11	R20	30K	±5%	31.5K	28.5K	50K (L)	3.50W	175W	±100	21	Q10								
11	R21	30K	±5%	31.5K	28.5K	50K (L)	220W	175W	±100	17	Q11								
11	R22	100K	±5%	105K	95K	50K (L)	100W	140W	±100	18	Q12								
10	R23	15K	±5%	15.75K	14.25K	10K (L)	170W	110W	±100	19	Q13								
8	R24	5.1	±10%	5.51	4.51	10 (L)	170W	100W	+200	20	Q14								
10	R25	5K	±5%	5.25K	4.75K	10K (L)	40W	100W	±100	21	Q15								
8	R26	2K	±5%	2.1K	1.9K	20 (L)	170W	100W	+100	17	Q16								
10	R27	9K	±2%	8.18K	8.82K	10K (L)	170W	100W	±100	18	Q17								
11	R28	30K	±5%	31.5K	28.5K	50K (L)	3.50W	175W	±100	19	Q18								
11	R29	30K	±5%	31.5K	28.5K	50K (L)	220W	175W	±100	20	Q19								
11	R30	100K	±5%	105K	95K	50K (L)	100W	140W	±100	21	Q20								
10	R31	15K	±5%	15.75K	14.25K	10K (L)	170W	110W	±100	18	Q21								
10	R32	5K	±5%	5.25K	4.75K	10K (L)	40W	100W	±100										
10	R33	15K	±5%	15.75K	14.25K	10K (L)	70W	110W	+100 PPM/°C	12	U1								
										12	U2								
										13	U3								
14	C1																		
14	C2																		
14	C3																		
14	C4																		
15	C5																		
15	C6																		
15	C7																		
15	C8																		
16	CR1																		
16	CR2																		
16	CR3																		

 SPERRY FLIGHT SYSTEMS PHOENIX, ARIZONA	FOR CONTRACT NUMBER WHEN APPLICABLE, SEE FIRST SHEET.	SIZE	FORM NO	DRAWING NO	REV
		B	07187	4026161	-
SCALE NONE		SHEET 4			

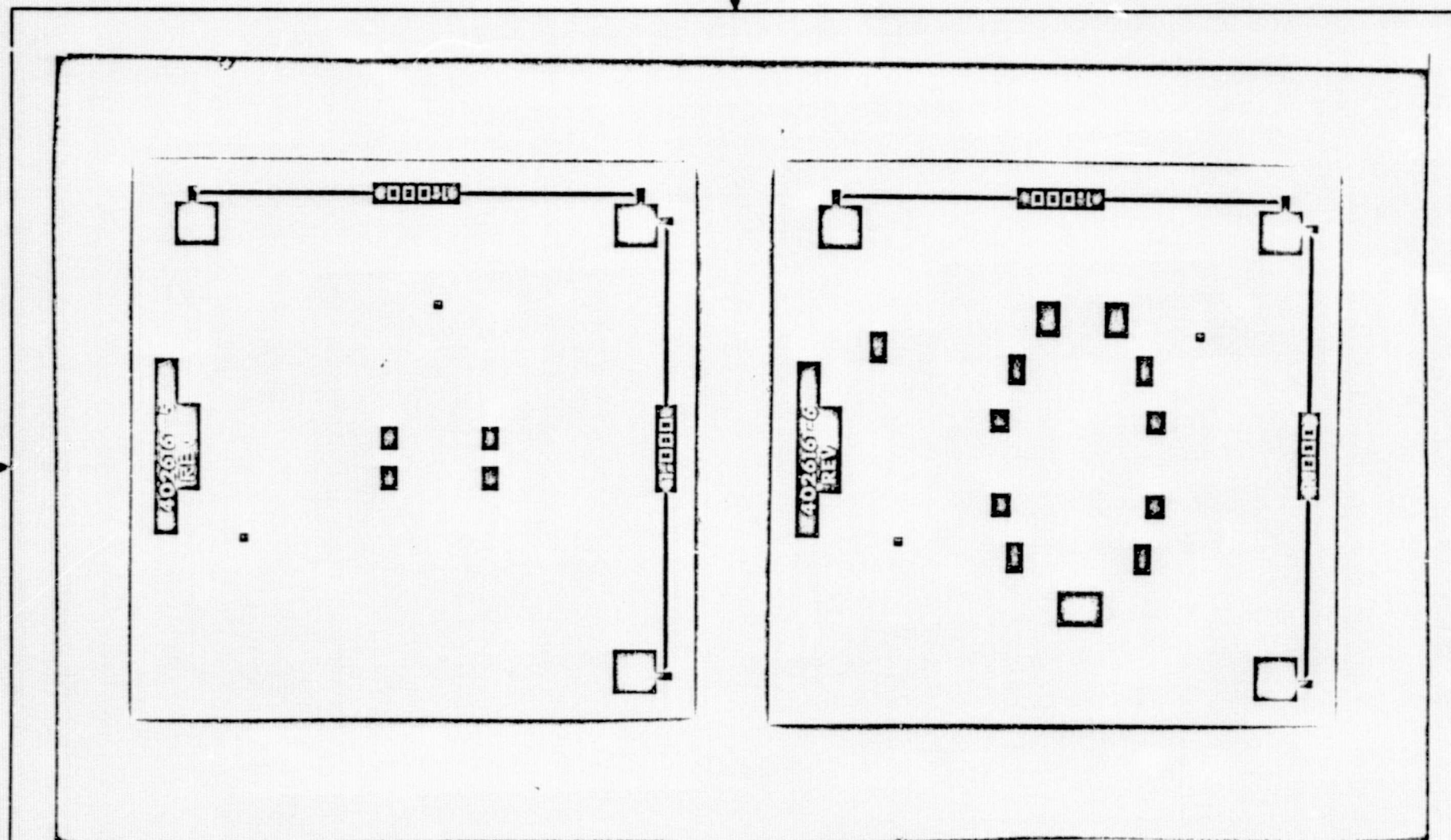
ORIGINAL PAGE IS
OF POOR QUALITY



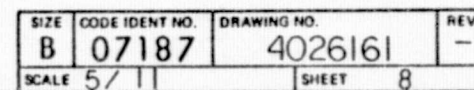
SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	07187	4026161	-
SCALE	5/1	SHEET	5



SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	07187	4026161	-
SCALE	5/1	SHEET	6



SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	07187	4026161	-
SCALE 5/11		SHEET 7	



ORIGINAL PAGE IS
OF POOR QUALITY

PARTS LIST REVISION RECORD	 SPERRY FLIGHT SYSTEMS PHOENIX, ARIZONA	PRODUCT ENGINEER D. Mitchell	CONTRACT NO. NAS9-15359	CODE IDENT NO. 07187	DRAWING NO. PL 4026161	REV LTR -
		DESIGN CHECKER S. Spears	END ITEM 4032521-901	TITLE MICROCIRCUIT-DO 2A DRIVER 2		DATE 22 DEC 77
		SPECIAL DESIGNATION	NEXT ASSY			S H E E T 2 OF 2

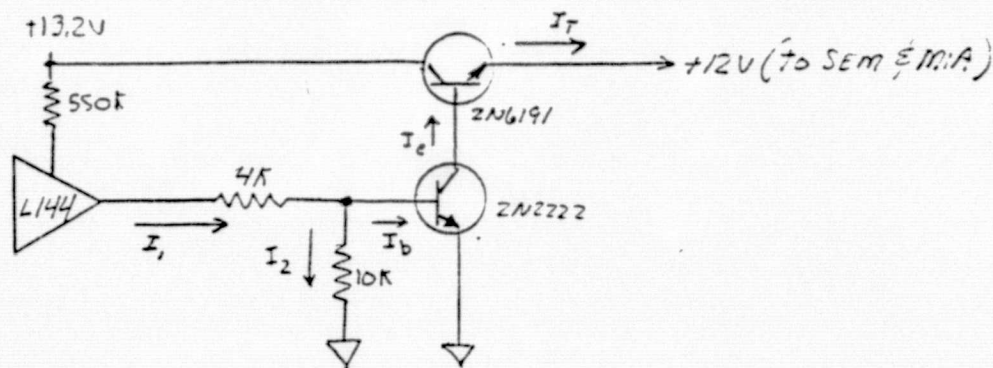
REV. LTR	DESCRIPTION OF REVISIONS	DATE			APPROVAL
		MO	DAY	YR	
	INITIAL RELEASE	12	22	77	<i>[Signature]</i>

SHEET INDEX	ALL SHEETS OF THIS DOCUMENT BEAR THE SAME REVISION LETTER.
CAUTION: REVISION STATUS OF PARTS LIST SHALL BE THE SAME AS BASIC DRAWING NUMBER.	
NOTE: SEE BASIC DRAWING FOR PROPRIETARY OR DATA RIGHTS NOTATIONS.	

APPENDIX V

ANALYSIS OF +12-VOLT MIA REGULATOR
FOR APPLICATION TO SEQUENCE MEMORY

+12VOLT MIA REGULATOR



CURRENT REQUIRED FOR MIA = 574ma

CURRENT REQUIRED FOR SEM = 80ma

$$I_T = 654ma$$

$$2N6191 \quad h_{fe_{min}} = 30$$

$$2N2222 \quad h_{fe_{min}} = 37.5$$

$$V_{ce_{max}} = 12V$$

$$I_C = \frac{I_T}{h_{fe_{min}} \text{ 2N6191}} = \frac{654}{30} = 21.8ma$$

$$I_{b \text{ needed}} = \frac{I_C}{h_{fe_{min}} \text{ 2N2222}} = \frac{21.8}{37.5} = 0.58ma$$

$$I_1 = 1.032ma \text{ (CURRENT AVAILABLE FROM L144)}$$

$$I_b = I_1 - I_2 = 1.032 - \frac{1.2}{10K} = 0.912ma$$

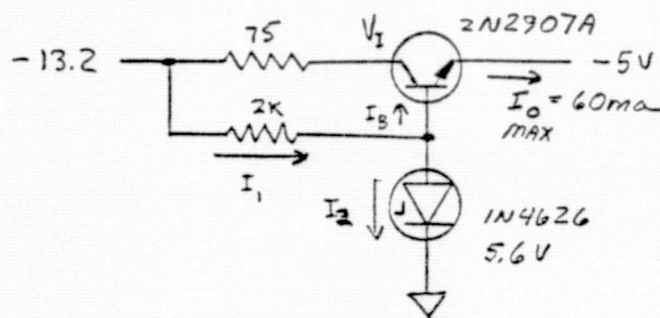
$I_b > I_{b \text{ needed}} \therefore$ SUFFICIENT CURRENT IS AVAILABLE

Figure 1

APPENDIX VI

ANALYSIS OF -5-VOLT SEQUENCE MEMORY REGULATOR

-5V ON BOARD REGULATOR



$$2N2907A \quad h_{fe \min} = 42.5 \quad V_{be} = .6 \text{ to } .8 \text{ volts} \quad V_{ce} = .3V$$

$$1N4626 \quad \text{TOLERANCE} = \pm 5\% \quad I_z = .25 \text{ ma}$$

$$V_z = 5.35V \text{ to } 5.85V$$

$$V_{out \max} = 5.85 - .6 = 5.25V$$

$$V_{out \min} = 5.35 - .8 = 4.55V$$

M2708 REQUIRES -4.5 TO -5.5 VOLTS

$\therefore$ REGULATOR SATISFIES MOTOR
VOLTAGE REQUIREMENTS

$$I_{t \min} = \frac{-12.54 - 5.35}{2.1k} = 3.18 \text{ ma}$$

$$I_{B \max} = \frac{60}{42.5} = 1.4 \text{ ma} \quad I_{z \min} = 3.18 - 1.4 = 1.78$$

$$I_z > I_z$$

$$V_{I \min} = 12.54 - .06(75) = 8.04V$$

$$V_{I \text{ needed}} = 5.25 + V_{ce \max} = 5.25 + .3 = 5.55 < V_{I \min}$$

$\therefore$ -5V WILL STAY IN REGULATION

FIGURE 2

ORIGINAL PAGE IS
OF POOR QUALITY

APPENDIX VII

FLEXIBLE MDM ATE TEST OUTPUT

YES
 ENTER MODULE TYPE FROM LIST
 0 = DI5 5 = TBD
 1 = DI28 6 = DCO
 2 = D05 7 = SD
 3 = D028 8 = DCIN
 4 = TBD 9 = P028

13 X = OPEN (NO MODULE)
 (LF) = REPEAT LAST IOM
 (SP) = NO CHANGE
 (RTN) = MIX OK AS IS

IOM# 0 IS D05 D028
 IOM# 1 IS SD DCIN
 IOM# 2 IS DCIN DCO
 IOM# 3 IS DI28 SD
 IOM# 4 IS DI5 D028
 IOM# 5 IS DCO DI28
 IOM# 6 IS DI28 DI5
 IOM# 7 IS D028 D05
 PRINT NEW MIX?(Y/N) YES

IOM# 0 IS D028
 IOM# 1 IS DCIN
 IOM# 2 IS DCO
 IOM# 3 IS SD
 IOM# 4 IS D028
 IOM# 5 IS DI28
 IOM# 6 IS DI5
 IOM# 7 IS D05
 IS MIX OK?(Y/N) YES
 IS EPROM TAPE REQUIRED?(Y/N) NO

FLEXIBLE MULTIPLEXER-DEMUTIPLEXER
 P/N 4032521-901 SERIAL #00001

A.T.E. SATAC 1000-29
 T NO:4033582 REV
 TAPE #37/38-1102-42-00
 DATE & TIME: 11/17/77

TEST STATUS: CHECK OUT
 10:00 AM
 10:00

IOM# 0 IS D028
 IOM# 1 IS DCIN
 IOM# 2 IS DCO
 IOM# 3 IS SD
 IOM# 4 IS D028
 IOM# 5 IS DI28
 IOM# 6 IS DI5
 IOM# 7 IS D05

ORIGINAL PAGE IS
 OF POOR QUALITY

FOLLOWING TEST SEQUENCE
 000001 + 02.119 KOHM
 000003 + 16.000 MEG
 000005 + 16.000 MEG
 000007 + 13.694 MEG

PER PAR 6. 01. 1
 PASS 000002
 PASS 000004
 PASS 000006
 PASS 000008

CONTINUITY TESTS
 + 16.000 MEG PASS
 + 16.000 MEG PASS
 + 000005 OHMS PASS

FOLLOWING TEST SEQUENCE
 000001 + 0002.5 OHMS
 000003 + 0002.5 OHMS
 000005 + 0002.5 OHMS
 000007 + 0002.5 OHMS
 000009 + 0002.6 OHMS
 000011 + 0002.5 OHMS
 000013 + 0002.6 OHMS
 000015 + 0002.8 OHMS

PER PAR 6. 01. 2
 PASS 000002
 PASS 000004
 PASS 000006
 PASS 000008
 PASS 000010
 PASS 000012
 PASS 000014
 PASS 000016

D028 IOM#00 RETURNS
 + 0000024 OHMS PASS
 + 0000026 OHMS PASS
 + 0000025 OHMS PASS
 + 0000027 OHMS PASS
 + 0000027 OHMS PASS
 + 0000026 OHMS PASS
 + 0000025 OHMS PASS
 + 0000025 OHMS PASS

FOLLOWING TEST SEQUENCE
 000001 + 0002.5 OHMS
 000003 + 0002.5 OHMS
 000005 + 0002.4 OHMS
 000007 + 0002.5 OHMS
 000009 + 0002.6 OHMS
 000011 + 0002.5 OHMS
 000013 + 0002.6 OHMS
 000015 + 0002.7 OHMS

PER PAR 6. 01. 3
 PASS 000002
 PASS 000004
 PASS 000006
 PASS 000008
 PASS 000010
 PASS 000012
 PASS 000014
 PASS 000016

D028 IOM#04 RETURNS
 + 0000024 OHMS PASS
 + 0000025 OHMS PASS
 + 0000024 OHMS PASS
 + 0000026 OHMS PASS
 + 0000026 OHMS PASS
 + 0000026 OHMS PASS
 + 0000025 OHMS PASS
 + 0000025 OHMS PASS

FOLLOWING TEST SEQUENCE
 000001 + 0005.8 OHMS
 000003 + 0005.9 OHMS
 000005 + 0003.8 OHMS

PER PAR 6. 01. 4
 PASS 000002
 PASS 000004
 PASS 000006

DI28 IOM#05 RETURNS
 + 0000058 OHMS PASS
 + 0000058 OHMS PASS
 + 0000039 OHMS PASS

000007 + 0003.8 OHMS PASS
000009 + 0004.2 OHMS PASS
000011 + 0004.2 OHMS PASS
000013 + 16.0000 MEG PASS
000015 + 16.0000 MEG PASS
000017 + 16.0000 MEG PASS
000019 + 16.0000 MEG PASS
000021 + 16.0000 MEG PASS

FOLLOWING TEST SEQUENCE PER PAR

000001 + 0005.3 OHMS PASS
000003 + 0005.3 OHMS PASS
000005 + 0003.9 OHMS PASS
000007 + 0003.9 OHMS PASS
000009 + 0004.2 OHMS PASS
000011 + 0004.2 OHMS PASS
000013 + 16.0000 MEG PASS
000015 + 16.0000 MEG PASS
000017 + 16.0000 MEG PASS
000019 + 16.0000 MEG PASS
000021 + 16.0000 MEG PASS

FOLLOWING TEST SEQUENCE PER PAR

000001 + 0003.1 OHMS PASS
000003 + 0003.1 OHMS PASS
000005 + 0003.1 OHMS PASS
000007 + 0003.1 OHMS PASS
000009 + 0003.2 OHMS PASS
000011 + 0003.1 OHMS PASS
000013 + 0003.1 OHMS PASS
000015 + 0003.3 OHMS PASS

FOLLOWING TEST SEQUENCE PER PAR

000001 137 077700 5 1 PASS
000003 137 077700 5 1 PASS
000005 137 077700 5 1 PASS
000007 137 077700 5 1 PASS
000009 137 077700 5 1 PASS
000011 137 077700 5 1 PASS
000013 137 077700 5 1 PASS
000015 137 077700 5 1 PASS
000017 137 077700 5 1 PASS
000019 137 077700 5 1 PASS
000021 137 077700 5 1 PASS
000023 137 077700 5 1 PASS
000025 137 077700 5 1 PASS
000027 137 077700 5 1 PASS
000029 137 077700 5 1 PASS
000031 137 077700 5 1 PASS
000033 137 077700 5 1 PASS
000035 137 077700 5 1 PASS
000037 137 077700 5 1 PASS
000039 137 077700 5 1 PASS
000041 137 077700 5 1 PASS
000043 137 077700 5 1 PASS
000045 137 077700 5 1 PASS

FOLLOWING TEST SEQUENCE PER PAR

000001 137 046160 5 0 PASS
000003 137 000000 5 0 PASS
000005 137 000400 5 1 PASS
000007 137 000400 5 1 PASS
000009 137 000400 5 1 PASS
000011 137 177777 5 0 PASS
000013 137 040000 5 1 PASS
000015 137 177777 5 0 PASS
000017 137 040000 5 1 PASS
000019 137 000400 5 1 PASS
000021 137 040000 5 1 PASS
000023 137 040000 5 1 PASS
000025 117 177774 5 1 PASS
000027 127 177774 5 1 PASS
000029 133 177774 5 1 PASS
000031 135 177774 5 1 PASS
000033 136 177774 5 1 PASS
000035 000 000000 0 0 PASS
000037 000 000000 0 0 PASS
000039 000 000000 0 0 PASS
000041 000 000000 0 0 PASS
000043 000 000000 0 0 PASS
000045 000 000000 0 0 PASS
000047 000 000000 0 0 PASS
000049 000 000000 0 0 PASS
000051 000 000000 0 0 PASS
000053 000 000000 0 0 PASS
000055 000 000000 0 0 PASS
000057 000 000000 0 0 PASS
000059 000 000000 0 0 PASS
000061 000 000000 0 0 PASS
000063 000 000000 0 0 PASS
000065 000 000000 0 0 PASS
000067 137 177774 5 0 PASS
000069 137 040000 5 1 PASS
000071 137 076763 5 0 PASS
000073 137 132000 5 0 PASS
000075 137 045000 5 0 PASS
000077 137 000046 5 1 PASS
000079 137 100000 5 1 PASS
000081 137 000000 5 0 PASS
000083 137 077700 5 1 PASS
000085 137 076763 5 0 PASS
000087 137 120000 5 0 PASS
000089 137 000000 5 0 PASS
000091 137 000000 5 0 PASS
000093 137 077700 5 1 PASS

000008 + 0003.8 OHMS PASS
000010 + 0004.41 OHMS PASS
000012 + 0004.40 OHMS PASS
000014 + 16.0000 MEG PASS
000016 + 16.0000 MEG PASS
000018 + 16.0000 MEG PASS
000020 + 16.0000 MEG PASS

6. 01. 5

DIS ION#06 RETURNS

000002 + 0005.2 OHMS PASS
000004 + 0005.2 OHMS PASS
000006 + 0004.1 OHMS PASS
000008 + 0003.8 OHMS PASS
000010 + 0004.42 OHMS PASS
000012 + 0004.41 OHMS PASS
000014 + 16.0000 MEG PASS
000016 + 16.0000 MEG PASS
000018 + 16.0000 MEG PASS
000020 + 16.0000 MEG PASS

6. 01. 6

DOS ION#07 RETURNS

000002 + 0003.31 OHMS PASS
000004 + 0003.31 OHMS PASS
000006 + 0003.30 OHMS PASS
000008 + 0003.32 OHMS PASS
000010 + 0003.32 OHMS PASS
000012 + 0003.32 OHMS PASS
000014 + 0003.31 OHMS PASS
000016 + 0003.31 OHMS PASS

6. 01. 10

POWER SUPPLY

000002 137 077700 5 1 PASS
000004 137 077700 5 1 PASS
000006 137 077700 5 1 PASS
000008 137 077700 5 1 PASS
000010 137 077700 5 1 PASS
000012 137 077700 5 1 PASS
000014 137 077700 5 1 PASS
000016 137 077700 5 1 PASS
000018 137 077700 5 1 PASS
000020 137 077700 5 1 PASS
000022 137 077700 5 1 PASS
000024 137 077700 5 1 PASS
000026 137 077700 5 1 PASS
000028 137 077700 5 1 PASS
000030 137 077700 5 1 PASS
000032 137 077700 5 1 PASS
000034 137 077700 5 1 PASS
000036 137 077700 5 1 PASS
000038 137 077700 5 1 PASS
000040 137 077700 5 1 PASS
000042 137 077700 5 1 PASS
000044 137 077700 5 1 PASS
000046 137 077700 5 1 PASS
000048 137 077700 5 1 PASS
000050 137 077700 5 1 PASS

6. 01. 12

SCU/AD

000002 137 000400 5 1 PASS
000004 137 000400 5 1 PASS
000006 137 000400 5 1 PASS
000008 137 000400 5 1 PASS
000010 137 000400 5 1 PASS
000012 137 000400 5 1 PASS
000014 137 000400 5 1 PASS
000016 137 000400 5 1 PASS
000018 137 000400 5 1 PASS
000020 137 000400 5 1 PASS
000022 137 000400 5 1 PASS
000024 137 000400 5 1 PASS
000026 137 000400 5 1 PASS
000028 137 000400 5 1 PASS
000030 137 000400 5 1 PASS
000032 137 000400 5 1 PASS
000034 137 000400 5 1 PASS
000036 137 000400 5 1 PASS
000038 137 000400 5 1 PASS
000040 137 000400 5 1 PASS
000042 137 000400 5 1 PASS
000044 137 000400 5 1 PASS
000046 137 000400 5 1 PASS
000048 137 000400 5 1 PASS
000050 137 000400 5 1 PASS
000052 137 000400 5 1 PASS
000054 137 000400 5 1 PASS
000056 137 000400 5 1 PASS
000058 137 000400 5 1 PASS
000060 137 000400 5 1 PASS
000062 137 000400 5 1 PASS
000064 137 000400 5 1 PASS
000066 137 000400 5 1 PASS
000068 137 000400 5 1 PASS
000070 137 000400 5 1 PASS
000072 137 000400 5 1 PASS
000074 137 000400 5 1 PASS
000076 137 000400 5 1 PASS
000078 137 000400 5 1 PASS
000080 137 000400 5 1 PASS
000082 137 000400 5 1 PASS
000084 137 000400 5 1 PASS
000086 137 000400 5 1 PASS
000088 137 000400 5 1 PASS
000090 137 000400 5 1 PASS
000092 137 000400 5 1 PASS
000094 137 000400 5 1 PASS
000096 137 000400 5 1 PASS
000098 137 000400 5 1 PASS
000100 137 000400 5 1 PASS

000094 137 876763 5 0 PASS
 000096 137 1320000 5 0 PASS
 000098 137 0450000 5 0 PASS
 000100 137 0000046 5 1 PASS
 PROM CONTENTS NOT PERFORMED!

000095 137 1 00000 5 1 PASS
 000097 137 0 00000 5 0 PASS
 000099 137 0 77000 5 1 PASS

FOLLOWING TEST SEQUENCE PER PAR

000027	137	00000000	5	0	PASS
000029	137	00000000	5	0	PASS
000031	137	1777777	5	0	PASS
000033	137	10000000	5	1	PASS
000035	137	00000000	5	0	PASS
000037	137	00000000	5	0	PASS
000039	137	02000000	5	1	PASS
000041	137	00000000	5	0	PASS
000043	137	00000000	5	0	PASS
000045	137	00040000	5	1	PASS
000047	137	00000000	5	0	PASS
000049	137	00000000	5	0	PASS
000051	137	00010000	5	1	PASS
000053	137	00000000	5	0	PASS
000055	137	00000000	5	0	PASS
000057	137	00002000	5	1	PASS
000059	137	00000000	5	0	PASS
000061	137	00000000	5	0	PASS
000063	137	00000400	5	1	PASS
000065	137	00000000	5	0	PASS
000067	137	00000000	5	0	PASS
000069	137	00000100	5	1	PASS
000071	137	00000000	5	0	PASS
000073	137	00000000	5	0	PASS
000075	137	00000002	5	1	PASS
000077	137	00000000	5	0	PASS
000079	137	00000000	5	0	PASS
000081	137	00000000	5	0	PASS
000083	137	00000000	5	0	PASS
000085	137	00400000	5	1	PASS
000087	137	00000000	5	0	PASS
000089	137	00000000	5	0	PASS
000091	137	01000000	5	1	PASS
000093	137	00000000	5	0	PASS
000095	137	00000000	5	0	PASS
000097	137	00020000	5	1	PASS
000099	137	00000000	5	0	PASS
000101	137	00000000	5	0	PASS
000103	137	00000400	5	1	PASS
000105	137	00000000	5	0	PASS
000107	137	00000000	5	0	PASS
000109	137	00000100	5	1	PASS
000111	137	00000000	5	0	PASS
000113	137	00000000	5	0	PASS
000115	137	00000200	5	1	PASS
000117	137	00000000	5	0	PASS
000119	137	00000000	5	0	PASS
000121	137	00000004	5	1	PASS
000123	137	00000000	5	0	PASS
000125	137	00000000	5	0	PASS
000127	137	00000001	5	1	PASS
000129	137	00000000	5	0	PASS
000131	137	10000000	5	1	PASS
000133	137	00000000	5	0	PASS
000135	137	00000000	5	0	PASS
000137	137	00200000	5	1	PASS
000139	137	00000000	5	0	PASS
000141	137	00000000	5	0	PASS
000143	137	00040000	5	1	PASS
000145	137	00000000	5	0	PASS
000147	137	00000000	5	0	PASS
000149	137	00010000	5	1	PASS
000151	137	00000000	5	0	PASS
000153	137	00000000	5	0	PASS
000155	137	00002000	5	1	PASS
000157	137	00000000	5	0	PASS
000159	137	00000000	5	0	PASS
000161	137	00000400	5	1	PASS
000163	137	00000000	5	0	PASS
000165	137	00000000	5	0	PASS
000167	137	00000001	5	1	PASS
000169	137	00000000	5	0	PASS
000171	137	00000000	5	0	PASS
000173	137	00000002	5	1	PASS
000175	137	00000000	5	0	PASS

6. 01. 16

000028	137	0 00000	5	0	PASS
000030	137	1 77777	5	0	PASS
000032	137	1 77777	5	0	PASS
000034	137	0 00000	5	0	PASS
000036	137	0 00000	5	1	PASS
000038	137	0 00000	5	0	PASS
000040	137	0 00000	5	0	PASS
000042	137	0 00000	5	1	PASS
000044	137	0 00000	5	0	PASS
000046	137	0 00000	5	0	PASS
000048	137	0 00000	5	1	PASS
000050	137	0 00000	5	0	PASS
000052	137	0 00000	5	0	PASS
000054	137	0 04000	5	1	PASS
000056	137	0 00000	5	0	PASS
000058	137	0 00000	5	0	PASS
000060	137	0 01000	5	1	PASS
000062	137	0 00000	5	0	PASS
000064	137	0 00000	5	0	PASS
000066	137	0 00200	5	1	PASS
000068	137	0 00000	5	0	PASS
000070	137	0 00000	5	0	PASS
000072	137	0 00004	5	1	PASS
000074	137	0 00000	5	0	PASS
000076	137	0 00000	5	0	PASS
000078	137	0 00001	5	1	PASS
000080	137	0 00000	5	0	PASS
000082	137	1 00000	5	1	PASS
000084	137	0 00000	5	0	PASS
000086	137	0 00000	5	0	PASS
000088	137	0 00000	5	1	PASS
000090	137	0 00000	5	0	PASS
000092	137	0 00000	5	0	PASS
000094	137	0 00000	5	1	PASS
000096	137	0 00000	5	0	PASS
000098	137	0 00000	5	0	PASS
000100	137	0 00000	5	1	PASS
000102	137	0 00000	5	0	PASS
000104	137	0 00000	5	0	PASS
000106	137	0 02000	5	1	PASS
000108	137	0 00000	5	0	PASS
000110	137	0 00000	5	0	PASS
000112	137	0 00400	5	1	PASS
000114	137	0 00000	5	0	PASS
000116	137	0 00000	5	0	PASS
000118	137	0 00010	5	1	PASS
000120	137	0 00000	5	0	PASS
000122	137	0 00000	5	0	PASS
000124	137	0 00002	5	1	PASS
000126	137	0 00000	5	0	PASS
000128	137	0 00000	5	0	PASS
000130	137	0 00000	5	0	PASS
000132	137	0 00000	5	0	PASS
000134	137	0 00000	5	1	PASS
000136	137	0 00000	5	0	PASS
000138	137	0 00000	5	0	PASS
000140	137	0 00000	5	1	PASS
000142	137	0 00000	5	0	PASS
000144	137	0 00000	5	0	PASS
000146	137	0 00000	5	1	PASS
000148	137	0 00000	5	0	PASS
000150	137	0 00000	5	0	PASS
000152	137	0 00400	5	1	PASS
000154	137	0 00000	5	0	PASS
000156	137	0 00000	5	0	PASS
000158	137	0 01000	5	1	PASS
000160	137	0 00000	5	0	PASS
000162	137	0 00000	5	0	PASS
000164	137	0 00200	5	1	PASS
000166	137	0 00000	5	0	PASS
000168	137	0 00000	5	0	PASS
000170	137	0 00004	5	1	PASS
000172	137	0 00000	5	0	PASS
000174	137	0 00000	5	0	PASS
000176	137	0 00001	5	1	PASS

ORIGINAL PAGE IS
 OF POOR QUALITY

TEST	SEQUENCE	PER	PAR	DI	ION	NO
000341	137	00000000	4	1	PASS	000341
000343	137	00000000	4	1	PASS	000343
000345	137	00000000	4	1	PASS	000345
000347	137	00000000	4	1	PASS	000347
000349	137	00000000	4	1	PASS	000349
000351	137	00000000	4	1	PASS	000351
000353	137	00000000	4	1	PASS	000353
000355	137	00000000	4	1	PASS	000355
000357	137	00000000	4	1	PASS	000357
000359	137	00000000	4	1	PASS	000359
000361	137	1700017	5	5	PASS	000361
000363	137	1703600	5	5	PASS	000363
000365	137	007417	5	5	PASS	000365
000367	137	007417	5	5	PASS	000367
000369	137	007417	5	5	PASS	000369
000371	137	1703600	5	5	PASS	000371
000373	137	00000000	5	5	PASS	000373
000375	137	1700017	5	5	PASS	000375
000377	137	1703600	5	5	PASS	000377
000379	137	007417	5	5	PASS	000379
FOLLOWING	TEST	SEQUENCE	PER	PAR	6	18
000381	137	00000000	5	5	PASS	000381
000383	137	00000000	5	5	PASS	000383
000385	137	1777777	5	5	PASS	000385
000387	137	10000000	5	1	PASS	000387
000389	137	00000000	5	5	PASS	000389
000391	137	00000000	5	5	PASS	000391
000393	137	02000000	5	1	PASS	000393
000395	137	00000000	5	5	PASS	000395
000397	137	00000000	5	5	PASS	000397
000399	137	00000000	5	5	PASS	000399
000401	137	00000000	5	1	PASS	000401
000403	137	00000000	5	5	PASS	000403
000405	137	00000000	5	5	PASS	000405
000407	137	00000000	5	5	PASS	000407
000409	137	00000000	5	5	PASS	000409
000411	137	00100000	5	1	PASS	000411
000413	137	00000000	5	5	PASS	000413
000415	137	00000000	5	5	PASS	000415
000417	137	00000000	5	5	PASS	000417
000419	137	00000000	5	5	PASS	000419
000421	137	00000000	5	5	PASS	000421
000423	137	00000000	5	5	PASS	000423
000425	137	00000000	5	5	PASS	000425
000427	137	00000000	5	5	PASS	000427
000429	137	00000000	5	5	PASS	000429
000431	137	00000000	5	5	PASS	000431
000433	137	00000000	5	5	PASS	000433
000435	137	00000000	5	5	PASS	000435
000437	137	00000000	5	5	PASS	000437
000439	137	00000000	5	5	PASS	000439
000441	137	00000000	5	5	PASS	000441
000443	137	00000000	5	5	PASS	000443
000445	137	00000000	5	5	PASS	000445
000447	137	00000000	5	5	PASS	000447
000449	137	00000000	5	5	PASS	000449
000451	137	00000000	5	5	PASS	000451
000453	137	00000000	5	5	PASS	000453
000455	137	00000000	5	5	PASS	000455
000457	137	00000000	5	5	PASS	000457
000459	137	00000000	5	5	PASS	000459
000461	137	0000				

TEST	SEQUENCE	PER	PAR	6.	81.	32	DO	5	10	107
000017	+ 004.29	VDC	PASS		000018	+ 004	09	VDC	PASS	
000019	+ 004.29	VDC	PASS		000020	+ 004	09	VDC	PASS	
000021	+ 004.28	VDC	PASS		000022	+ 004	09	VDC	PASS	
000023	+ 004.29	VDC	PASS		000024	+ 004	11	VDC	PASS	
000025	+ 004.29	VDC	PASS		000026	+ 004	08	VDC	PASS	
000027	+ 004.29	VDC	PASS		000028	+ 004	09	VDC	PASS	
000029	+ 004.29	VDC	PASS		000030	+ 004	09	VDC	PASS	
000031	+ 004.28	VDC	PASS		000032	+ 004	09	VDC	PASS	
000033	+ 004.29	VDC	PASS		000034	+ 004	09	VDC	PASS	
000035	+ 004.28	VDC	PASS		000036	+ 004	07	VDC	PASS	
000037	+ 004.30	VDC	PASS		000038	+ 004	07	VDC	PASS	
000039	+ 004.29	VDC	PASS		000040	+ 004	09	VDC	PASS	
000041	+ 004.31	VDC	PASS		000042	+ 004	09	VDC	PASS	
000043	+ 004.29	VDC	PASS		000044	+ 004	00	VDC	PASS	
000045	+ 004.30	VDC	PASS		000046	+ 004	09	VDC	PASS	
000047	+ 004.29	VDC	PASS		000048	+ 004	09	VDC	PASS	
000049	+ 004.28	VDC	PASS		000050	+ 004	09	VDC	PASS	
000051	+ 004.29	VDC	PASS		000052	+ 004	08	VDC	PASS	
000053	+ 004.31	VDC	PASS		000054	+ 004	08	VDC	PASS	
000055	+ 004.29	VDC	PASS		000056	+ 004	09	VDC	PASS	
000057	+ 004.30	VDC	PASS		000058	+ 004	03	VDC	PASS	
000059	+ 004.30	VDC	PASS		000060	+ 004	08	VDC	PASS	
000061	+ 004.27	VDC	PASS		000062	+ 004	08	VDC	PASS	
000063	+ 004.28	VDC	PASS		000064	+ 004	09	VDC	PASS	
000065	+ 004.30	VDC	PASS		000066	+ 000	00	VDC	PASS	
000067	+ 004.29	VDC	PASS		000068	+ 000	00	VDC	PASS	
000069	+ 004.30	VDC	PASS		000070	+ 000	00	VDC	PASS	
000071	+ 004.30	VDC	PASS		000072	+ 000	00	VDC	PASS	
000073	+ 004.30	VDC	PASS		000074	+ 000	09	VDC	PASS	
000075	+ 004.30	VDC	PASS		000076	+ 000	09	VDC	PASS	
000077	+ 004.30	VDC	PASS		000078	+ 000	09	VDC	PASS	
000079	+ 004.31	VDC	PASS		000080	+ 000	09	VDC	PASS	
000081	+ 004.30	VDC	PASS		000082	+ 000	00	VDC	PASS	
000083	+ 004.30	VDC	PASS		000084	+ 000	00	VDC	PASS	
000085	+ 004.31	VDC	PASS		000086	+ 000	00	VDC	PASS	
000087	+ 004.29	VDC	PASS		000088	+ 000	09	VDC	PASS	
000089	+ 004.31	VDC	PASS		000090	+ 000	00	VDC	PASS	
000091	+ 004.30	VDC	PASS		000092	+ 000	11	VDC	PASS	
000093	+ 004.30	VDC	PASS		000094	+ 000	00	VDC	PASS	
000095	+ 004.30	VDC	PASS		000096	+ 000	00	VDC	PASS	
000097	+ 004.31	VDC	PASS		000098	+ 000	00	VDC	PASS	
000099	+ 004.30	VDC	PASS		000100	+ 000	09	VDC	PASS	
000101	+ 004.31	VDC	PASS		000102	+ 000	00	VDC	PASS	
000103	+ 004.30	VDC	PASS		000104	+ 000	02	VDC	PASS	
000105	+ 004.31	VDC	PASS		000106	+ 000	09	VDC	PASS	
000107	+ 004.30	VDC	PASS		000108	+ 000	01	VDC		

0003328	137	146	314	5	5	PASS	000329	137	5	5	PASS
0003330	137	125	252	5	5	PASS	000331	137	5	5	PASS
0003332	137	146	314	5	5	PASS	000333	137	5	5	PASS
0003334	137	125	252	5	5	PASS	000335	137	5	5	PASS
FOLLOWING	TEST	SEQUENCE	PER	PAR	6.	01.	34	DO	28	IO	#
000017	+	024.55	VDC	PASS		00018	+	024	7	VDC	
000019	+	024.57	VDC	PASS		00020	+	024	7	VDC	
000021	+	024.58	VDC	PASS		00022	+	024	7	VDC	
000023	+	024.58	VDC	PASS		00024	+	024	6	VDC	
000025	+	024.55	VDC	PASS		00026	+	024	8	VDC	
000027	+	024.58	VDC	PASS		00028	+	024	6	VDC	
000029	+	024.54	VDC	PASS		00030	+	024	7	VDC	
000031	+	024.58	VDC	PASS		00032	+	024	7	VDC	
000033	+	024.60	VDC	PASS		00034	+	024	9	VDC	
000035	+	024.59	VDC	PASS		00036	+	024	6	VDC	
000037	+	024.59	VDC	PASS		00038	+	024	9	VDC	
000039	+	024.59	VDC	PASS		00040	+	024	9	VDC	
000041	+	024.59	VDC	PASS		00042	+	024	7	VDC	
000043	+	024.56	VDC	PASS		00044	+	024	1	VDC	
000045	+	024.62	VDC	PASS		00046	+	024	9	VDC	
000047	+	024.60	VDC	PASS		00048	+	024	6	VDC	
000049	+	024.56	VDC	PASS		00050	+	024	1	VDC	
000051	+	024.60	VDC	PASS		00052	+	024	0	VDC	
000053	+	024.60	VDC	PASS		00054	+	024	0	VDC	
000055	+	024.59	VDC	PASS		00056	+	024	1	VDC	
000057	+	024.58	VDC	PASS		00058	+	024	0	VDC	
000059	+	024.58	VDC	PASS		00060	+	024	0	VDC	
000061	+	024.59	VDC	PASS		00062	+	024	8	VDC	
000063	+	024.58	VDC	PASS		00064	+	024	9	VDC	
000065	+	000.00	VDC	PASS		00066	+	000	0	VDC	
000067	+	000.00	VDC	PASS		00068	+	000	0	VDC	
000069	+	000.00	VDC	PASS		00070	+	000	0	VDC	
000071	+	000.00	VDC	PASS		00072	+	000	0	VDC	
000073	+	000.00	VDC	PASS		00074	+	000	0	VDC	
000075	+	000.00	VDC	PASS		00076	+	000	0	VDC	
000077	+	000.00	VDC	PASS		00078	+	000	0	VDC	
000079	+	000.00	VDC	PASS		00080	+	000	0	VDC	
000081	+	000.00	VDC	PASS		00082	+	000	0	VDC	
000083	+	000.00	VDC	PASS		00084	+	000	0	VDC	
000085	+	000.00	VDC	PASS		00086	+	000	0	VDC	
000087	+	000.00	VDC	PASS		00088	+	000	0	VDC	
000089	+	000.00	VDC	PASS		00090	+	000	0	VDC	
000091	+	000.00	VDC	PASS		00092	+	000	0	VDC	
000093	+	000.00	VDC	PASS		00094	+	000	0	VDC	
000095	+	000.00	VDC	PASS		00096	+	000	0	VDC	
000097	+	000.00	VDC	PASS		00098	+	000	0	VDC	
000099	+	000.00	VDC</								

[illegible]

ORIGINAL PAGE IS
OF POOR QUALITY

[illegible][illegible][illegible][illegible][illegible][illegible]

[illegible][illegible][illegible][illegible]

001108
001110
001112
001114
001116
001118
001200
001222
001244
001266
001288
001300
001322
001344
001366
001400
001422
001444
001466
001488
001500
001522
001544
001566
001588
001600
001622
001644
001666
001688
001700
001722
001744
001766
001788
001800
001822
001844
001866
001888
001900
001922
001944
001966
001988
002000
002022
002044
002066
002088
002100
002122
002144
002166
002188
002200
002222
002244
002266
002288
002300
002322
002344
002366
002388
002400
002422
002444
002466
002488
002500
002522
002544
002566
002588
002600
002622
002644
002666
002688
002700

[illegible][illegible][illegible][illegible]

ORIGINAL PAGE IS
OF POOR QUALITY

000927	+	000177	MY^2	PASS
000929	+	000143	GAIN	PASS
000931	+	000144	GAIN	PASS
000933	+	000145	GAIN	PASS
000935	+	000145	GAIN	PASS
000937	+	000143	GAIN	PASS
000939	+	000144	GAIN	PASS
000941	+	000144	GAIN	PASS
000943	+	000145	GAIN	PASS
000945	+	000146	GAIN	PASS
000947	+	000144	GAIN	PASS
000949	+	000143	GAIN	PASS
000951	+	000146	GAIN	PASS
000953	+	000145	GAIN	PASS
000955	+	000144	GAIN	PASS
000957	+	000143	GAIN	PASS
000959	+	000144	GAIN	PASS
000961	+	000138	GAIN	PASS
000963	+	000135	GAIN	PASS
000965	+	000131	GAIN	PASS
000967	+	000131	GAIN	PASS
000969	+	000138	GAIN	PASS
000971	+	000131	GAIN	PASS
000973	+	000131	GAIN	PASS
000975	+	000132	GAIN	PASS
000977	+	000129	GAIN	PASS
000979	+	000131	GAIN	PASS
000981	+	000138	GAIN	PASS
000983	+	000129	GAIN	PASS
000985	+	000131	GAIN	PASS
000987	+	000131	GAIN	PASS
000989	+	000138	GAIN	PASS
000991	+	000135	GAIN	PASS
000993	+	000121	BIITE	PASS
000995	-	000122	BIITE	PASS
000997	-	000121	BIITE	PASS
000999	+	000122	BIITE	PASS
001001	-	000122	BIITE	PASS
001003	+	000122	BIITE	PASS
001005	+	000122	BIITE	PASS
001007	-	000122	BIITE	PASS
001009	-	000122	BIITE	PASS
001011	+	000122	BIITE	PASS
001013	+	000122	BIITE	PASS
001015	-	000122	BIITE	PASS
001017	+	000122	BIITE	PASS
001019	-	000122	BIITE	PASS
001021	-	000122	BIITE	PASS
001023	+	000122	BIITE	PASS
001025	137	000122	BIITE	PASS
001027	-	000122	BIITE	PASS
001029	+	000122	BIITE	PASS
001031	+	000122	BIITE	PASS
001033	-	000122	BIITE	PASS
001035	+	000122	BIITE	PASS
001037	-	000122	BIITE	PASS
001039	-	000122	BIITE	PASS
001041	+	000122	BIITE	PASS
001043	+	000122	BIITE	PASS
001045	-	000122	BIITE	PASS
001047	-	000122	BIITE	PASS
001049	+	000122	BIITE	PASS
001051	-	000122	BIITE	PASS
001053	+	000122	BIITE	PASS
001055	+	000122	BIITE	PASS
001057	-	000122	BIITE	PASS
001059	+	000122	BIITE	PASS
001061	-	000122	BIITE	PASS
001063	-	000122	BIITE	PASS
001065	+	000122	BIITE	PASS
001067	-	000122	BIITE	PASS
001069	+	000122	BIITE	PASS
001071	+	000122	BIITE	PASS
001073	-	000122	BIITE	PASS
001075	-	000122	BIITE	PASS
001077	+	000122	BIITE	PASS
001079	+	000122	BIITE	PASS
001081	-	000122	BIITE	PASS
001083	+	000122	BIITE	PASS
001085	-	000122	BIITE	PASS
001087	-	000122	BIITE	PASS
001089	+	000122	BIITE	PASS

000928	+	000214	MY^2	PASS
000930	+	000241	GAIN	PASS
000932	+	000241	GAIN	PASS
000934	+	000241	GAIN	PASS
000936	+	000241	GAIN	PASS
000938	+	000241	GAIN	PASS
000940	+	000241	GAIN	PASS
000942	+	000241	GAIN	PASS
000944	+	000241	GAIN	PASS
000946	+	000241	GAIN	PASS
000948	+	000241	GAIN	PASS
000950	+	000241	GAIN	PASS
000952	+	000241	GAIN	PASS
000954	+	000241	GAIN	PASS
000956	+	000241	GAIN	PASS
000958	+	000241	GAIN	PASS
000960	+	000241	GAIN	PASS
000962	+	000241	GAIN	PASS
000964	+	000241	GAIN	PASS
000966	+	000241	GAIN	PASS
000968	+	000241	GAIN	PASS
000970	+	000241	GAIN	PASS
000972	+	000241	GAIN	PASS
000974	+	000241	GAIN	PASS
000976	+	000241	GAIN	PASS
000978	+	000241	GAIN	PASS
000980	+	000241	GAIN	PASS
000982	+	000241	GAIN	PASS
000984	+	000241	GAIN	PASS
000986	+	000241	GAIN	PASS
000988	+	000241	GAIN	PASS
000990	+	000241	GAIN	PASS
000992	+	000241	GAIN	PASS
000994	-	000241	BIITE	PASS
000996	+	000241	BIITE	PASS
000998	+	000241	BIITE	PASS
001000	-	000241	BIITE	PASS
001002	+	000241	BIITE	PASS
001004	-	000241	BIITE	PASS
001006	-	000241	BIITE	PASS
001008	+	000241	BIITE	PASS
001010	-	000241	BIITE	PASS
001012	-	000241	BIITE	PASS
001014	-	000241	BIITE	PASS
001016	+	000241	BIITE	PASS
001018	-	000241	BIITE	PASS
001020	+	000241	BIITE	PASS
001022	+	000241	BIITE	PASS
001024	+	000241	BIITE	PASS
001026	+	000241	BIITE	PASS
001028	-	000241	BIITE	PASS
001030	+	000241	BIITE	PASS
001032	+	000241	BIITE	PASS
001034	-	000241	BIITE	PASS
001036	+	000241	BIITE	PASS
001038	+	000241	BIITE	PASS
001040	-	000241	BIITE	PASS
001042	-	000241	BIITE	PASS
001044	+	000241	BIITE	PASS
001046	+	000241	BIITE	PASS
001048	-	000241	BIITE	PASS
001050	+	000241	BIITE	PASS
001052	-	000241	BIITE	PASS
001054	-	000241	BIITE	PASS
001056	+	000241	BIITE	PASS
001058	137	000241	BIITE	PASS
001060	-	000241	BIITE	PASS
001062	+	000241	BIITE	PASS
001064	+	000241	BIITE	PASS
001066	+	000241	BIITE	PASS
001068	-	000241	BIITE	PASS
001070	-	000241	BIITE	PASS
001072	+	000241	BIITE	PASS
001074	+	000241	BIITE	PASS
001076	+	000241	BIITE	PASS
001078	-	000241	BIITE	PASS
001080	+	000241	BIITE	PASS
001082	+	000241	BIITE	PASS
001084	-	000241	BIITE	PASS
001086	+	000241	BIITE	PASS
001088	+	000241	BIITE	PASS
001090	-	000241	BIITE	PASS

FAT

010991	137	000000	00	5	0	PASS	01092	137	+	00	5	0	PASS
010993	137	000000	00	5	0	PASS	01094	137	+	00	5	1	PASS
010995	137	000000	00	5	1	PASS	01096	137	000000	00	5	0	PASS
FOLLOWING	TEST	SEQUENCE			PER PAR	6.	01. 64	DC0				ION#02	
000001	+	04.789	VDC		PASS		000002	+	04.789	VDC		PASS	
000003	+	04.843	VDC		PASS		000004	+	04.843	VDC		PASS	
000005	+	04.812	VDC		PASS		000006	+	04.812	VDC		PASS	
000007	+	04.923	VDC		PASS		000008	+	04.923	VDC		PASS	
000009	+	04.996	VDC		PASS		000010	+	04.996	VDC		PASS	
000011	+	04.804	VDC		PASS		000012	+	04.804	VDC		PASS	
000013	+	04.756	VDC		PASS		000014	+	04.756	VDC		PASS	
000015	+	04.915	VDC		PASS		000016	+	05.000	VDC		PASS	
000017	+	05.001	VDC		PASS		000018	+	05.000	VDC		PASS	
000019	+	05.061	VDC		PASS		000020	+	05.061	VDC		PASS	
000021	+	05.073	VDC		PASS		000022	+	05.069	VDC		PASS	
000023	+	05.093	VDC		PASS		000024	+	05.067	VDC		PASS	
000025	+	05.082	VDC		PASS		000026	+	05.073	VDC		PASS	
000027	+	05.100	VDC		PASS		000028	+	05.066	VDC		PASS	
000029	+	05.084	VDC		PASS		000030	+	05.076	VDC		PASS	
000033	+	05.092	VDC		PASS		000034	-	05.071	VDC		PASS	
000035	+	05.093	VDC		PASS		000036	-	05.084	VDC		PASS	
000037	+	05.073	VDC		PASS		000038	-	05.082	VDC		PASS	
000039	+	05.107	VDC		PASS		000040	-	05.085	VDC		PASS	
000041	+	05.074	VDC		PASS		000042	-	05.110	VDC		PASS	
000043	+	05.082	VDC		PASS		000044	-	05.098	VDC		PASS	
000045	+	05.116	VDC		PASS		000046	-	05.092	VDC		PASS	
000047	+	05.088	VDC		PASS		000048	-	05.097	VDC		PASS	
000049	+	05.092	VDC		PASS		000050	+	05.095	VDC		PASS	
000051	-	05.097	VDC		PASS		000052	+	05.084	VDC		PASS	
000053	+	05.073	VDC		PASS		000054	-	05.081	VDC		PASS	
000055	-	05.132	VDC		PASS		000056	-	05.075	VDC		PASS	
000057	+	05.075	VDC		PASS		000058	+	05.093	VDC		PASS	
000059	-	05.095	VDC		PASS		000060	+	05.098	VDC		PASS	
000061	+	05.116	VDC		PASS		000062	+	05.095	VDC		PASS	
000063	-	05.097	VDC		PASS		000064	-	05.097	VDC		PASS	
000065	+	05.092	VDC		PASS		000066	+	05.094	VDC		PASS	
000067	+	05.093	VDC		PASS		000068	+	05.094	VDC		PASS	
000069	-	05.092	VDC		PASS		000070	-	05.092	VDC		PASS	
000071	-	05.132	VDC		PASS		000072	-	05.095	VDC		PASS	
000073	+	05.075	VDC		PASS		000074	+	05.093	VDC		PASS	
000075	+	05.082	VDC		PASS		000076	+	05.093	VDC			

00406	+	00000	VDC	PASS	00407	+	00001	VDC	PASS
00408	+	00003	VDC	PASS	00409	+	00003	VDC	PASS
00410	+	00005	VDC	PASS	00411	+	00005	VDC	PASS
00412	+	00007	VDC	PASS	00413	+	00007	VDC	PASS
00414	+	00009	VDC	PASS	00415	+	00009	VDC	PASS
00416	+	00011	VDC	PASS	00417	+	00011	VDC	PASS
00418	+	00013	VDC	PASS	00419	+	00013	VDC	PASS
00420	+	00015	VDC	PASS	00421	+	00015	VDC	PASS
00422	+	00017	VDC	PASS	00423	+	00017	VDC	PASS
00424	+	00019	VDC	PASS	00425	+	00019	VDC	PASS
00426	+	00021	VDC	PASS	00427	+	00021	VDC	PASS
00428	+	00023	VDC	PASS	00429	+	00023	VDC	PASS
00430	+	00025	VDC	PASS	00431	+	00025	VDC	PASS
00432	+	00027	VDC	PASS	00433	+	00027	VDC	PASS
00434	+	00029	VDC	PASS	00435	+	00029	VDC	PASS
00436	+	00031	VDC	PASS	00437	+	00031	VDC	PASS
00438	+	00033	VDC	PASS	00439	+	00033	VDC	PASS
00440	+	00035	VDC	PASS	00441	+	00035	VDC	PASS
00442	+	00037	VDC	PASS	00443	+	00037	VDC	PASS
00444	+	00039	VDC	PASS	00445	+	00039	VDC	PASS
00446	+	00041	VDC	PASS	00447	+	00041	VDC	PASS
00448	+	00043	VDC	PASS	00449	+	00043	VDC	PASS
00450	+	00045	VDC	PASS	00451	+	00045	VDC	PASS
00452	+	00047	VDC	PASS	00453	+	00047	VDC	PASS
00454	+	00049	VDC	PASS	00455	+	00049	VDC	PASS
00456	+	00051	VDC	PASS	00457	+	00051	VDC	PASS
00458	+	00053	VDC	PASS	00459	+	00053	VDC	PASS
00460	+	00055	VDC	PASS	00461	+	00055	VDC	PASS
00462	+	00057	VDC	PASS	00463	+	00057	VDC	PASS
00464	+	00059	VDC	PASS	00465	+	00059	VDC	PASS
00466	+	00061	VDC	PASS	00467	+	00061	VDC	PASS
00468	+	00063	VDC	PASS	00469	+	00063	VDC	PASS
00470	+	00065	VDC	PASS	00471	+	00065	VDC	PASS
00472	+	00067	VDC	PASS	00473	+	00067	VDC	PASS
00474	+	00069	VDC	PASS	00475	+	00069	VDC	PASS
00476	+	00071	VDC	PASS	00477	+	00071	VDC	PASS
00478	+	00073	VDC	PASS	00479	+	00073	VDC	PASS
00480	+	00075	VDC	PASS	00481	+	00075	VDC	PASS
00482	+	00077	VDC	PASS	00483	+	00077	VDC	PASS
00484	+	00079	VDC	PASS	00485	+	00079	VDC	PASS
00486	+	00081	VDC	PASS	00487	+	00081	VDC	PASS
00488	+	00083	VDC	PASS	00489	+	00083	VDC	PASS
00490	+	00085	VDC	PASS	00491	+	00085	VDC	PASS
00492	+	00087	VDC	PASS	00493	+	00087	VDC	PASS
00494	+	00089	VDC	PASS	00495	+	00089	VDC	PASS
00496	+	00091	VDC	PASS	00497	+	00091	VDC	PASS
00498	+	00093	VDC	PASS	00499	+	00093	VDC	PASS
00500	+	00095	VDC	PASS	00501	+	00095	VDC	PASS
00502	+	00097	VDC	PASS	00503	+	00097	VDC	PASS
00504	+	00099	VDC	PASS	00505	+	00099	VDC	PASS
00506	+	00101	VDC	PASS	00507	+	00101	VDC	PASS
00508	+	00103	VDC	PASS	00509	+	00103	VDC	PASS
00510	+	00105	VDC	PASS	00511	+	00105	VDC	PASS
00512	+	00107	VDC	PASS	00513	+	00107	VDC	PASS
00514	+	00109	VDC	PASS	00515	+	00109	VDC	PASS
00516	+	00111	VDC	PASS	00517	+	00111	VDC	PASS
00518	+	00113	VDC	PASS	00519	+	00113	VDC	PASS
00520	+	00115	VDC	PASS	00521	+	00115	VDC	PASS
00522	+	00117	VDC	PASS	00523	+	00117	VDC	PASS
00524	+	00119	VDC	PASS	00525	+	00119	VDC	PASS
00526	+	00121	VDC	PASS	00527	+	00121	VDC	PASS
00528	+	00123	VDC	PASS	00529	+	00123	VDC	PASS
00530	+	00125	VDC	PASS	00531	+	00125	VDC	PASS
00532	+	00127	VDC	PASS	00533	+	00127	VDC	PASS
00534	+	00129	VDC	PASS	00535	+	00129	VDC	PASS
00536	+	00131	VDC	PASS	00537	+	00131	VDC	PASS
00538	+	00133	VDC	PASS	00539	+	00133	VDC	PASS
00540	+	00135	VDC	PASS	00541	+	00135	VDC	PASS
00542	+	00137	VDC	PASS	00543	+	00137	VDC	PASS
00544	+	00139	VDC	PASS	00545	+	00139	VDC	PASS
00546	+	00141	VDC	PASS	00547	+	00141	VDC	PASS
00548	+	00143	VDC	PASS	00549	+	00143	VDC	PASS
00550	+	00145	VDC	PASS	00551	+	00145	VDC	PASS
00552	+	00147	VDC	PASS	00553	+	00147	VDC	PASS
00554	+	00149	VDC	PASS	00555	+	00149	VDC	PASS
00556	+	00151	VDC	PASS	00557	+	00151	VDC	PASS
00558	+	00153	VDC	PASS	00559	+	00153	VDC	PASS
00560	+	00155	VDC	PASS	00561	+	00155	VDC	PASS
00562	+	00157	VDC	PASS	00563	+	00157	VDC	PASS
00564	+	00159	VDC	PASS	00565	+	00159	VDC	PASS
00566	+	00161	VDC	PASS	00567	+	00161	VDC	PASS
00568	+	00163	VDC	PASS	00569	+	00163	VDC	PASS

000335	137	000100	1	PASS
000333	137	000000	1	PASS
000333	137	000000	1	PASS
000341	137	000000	1	PASS
000343	137	040000	1	PASS
000345	137	010000	1	PASS
000347	137	000000	1	PASS
000349	137	000000	1	PASS
000351	137	000000	1	PASS
000353	137	000000	1	PASS
000355	137	000000	1	PASS
000357	137	000000	1	PASS
000359	137	000000	1	PASS
000361	137	010000	1	PASS
000363	137	002000	1	PASS
000365	137	000400	1	PASS
000367	137	000100	1	PASS
000369	137	000020	1	PASS
000371	137	000004	1	PASS
000373	137	000001	1	PASS
000375	137	040000	1	PASS
000377	137	010000	1	PASS
000379	137	002000	1	PASS
000381	137	000400	1	PASS
000383	137	000100	1	PASS
000385	137	000020	1	PASS
000387	137	000004	1	PASS
000389	137	125252	5	PASS
000391	137	000000	5	PASS
000393	137	052525	5	PASS
000395	137	125252	5	PASS
000397	137	000000	5	PASS
000399	-	04.684 VDC		PASS

PROM SEQUENCE NOT PERFORMED!

003336	137	000400	1	PASS
003338	137	000100	1	PASS
003340	137	000020	1	PASS
003342	137	000004	1	PASS
003344	137	000001	1	PASS
003346	137	000000	1	PASS
003348	137	000000	1	PASS
003350	137	000000	1	PASS
003352	137	000000	1	PASS
003354	137	000000	1	PASS
003356	137	000000	1	PASS
003358	137	000000	1	PASS
003360	137	000000	1	PASS
003362	137	000000	1	PASS
003364	137	000000	1	PASS
003366	137	000000	1	PASS
003368	137	000000	1	PASS
003370	137	000000	1	PASS
003372	137	000000	1	PASS
003374	137	000000	1	PASS
003376	137	000000	1	PASS
003378	137	000000	1	PASS
003380	137	000000	1	PASS
003382	137	000000	1	PASS
003384	137	000000	1	PASS
003386	137	000000	1	PASS
003388	137	000000	1	PASS
003390	137	000000	1	PASS
003392	137	000000	1	PASS
003394	137	000000	1	PASS
003396	137	000000	1	PASS
003398	137	000000	1	PASS
004000	-	04.682 VDC		PASS

*ARE MANUAL SCOPE TESTS TO BE PERFORMED (Y/N)? NO

END OF TEST

ORIGINAL PAGE IS
OF POOR QUALITY

FOLLOWING TEST SEQUENCE				PER PAR	6. 01. 96	P028 IOM#06			
00017	+	025.00	VDC	PASS	00018	+	024.77	VDC	PASS
00019	+	024.76	VDC	PASS	00020	+	024.76	VDC	PASS
00021	+	023.90	VDC	PASS	00022	+	023.88	VDC	PASS
00023	+	023.87	VDC	PASS	00024	+	023.94	VDC	PASS
00025	+	023.92	VDC	PASS	00026	+	023.90	VDC	PASS
00027	+	023.92	VDC	PASS	00028	+	023.88	VDC	PASS
00029	+	023.91	VDC	PASS	00030	+	023.95	VDC	PASS
00031	+	023.92	VDC	PASS	00032	+	023.83	VDC	PASS
00033	+	023.96	VDC	PASS	00034	+	023.96	VDC	PASS
00035	+	024.02	VDC	PASS	00036	+	023.96	VDC	PASS
00037	+	023.94	VDC	PASS	00038	+	023.99	VDC	PASS
00039	+	023.97	VDC	PASS	00040	+	023.93	VDC	PASS
00041	+	023.95	VDC	PASS	00042	+	023.98	VDC	PASS
00043	+	023.87	VDC	PASS	00044	+	023.98	VDC	PASS
00045	+	023.97	VDC	PASS	00046	+	023.95	VDC	PASS
00047	+	024.00	VDC	PASS	00048	+	024.04	VDC	PASS
00049	+	023.93	VDC	PASS	00050	+	024.01	VDC	PASS

00051	+	023.94	VDC	PASS
00053	+	023.90	VDC	PASS
00055	+	023.96	VDC	PASS
00057	+	023.95	VDC	PASS
00059	+	023.99	VDC	PASS
00061	+	023.95	VDC	PASS
00063	+	023.92	VDC	PASS
00065	+	000.00	VDC	PASS
00067	+	000.00	VDC	PASS
00069	+	000.00	VDC	PASS
00071	+	000.00	VDC	PASS
00073	+	000.00	VDC	PASS
00075	+	000.00	VDC	PASS
00077	+	000.00	VDC	PASS
00079	+	000.00	VDC	PASS
00081	-	000.01	VDC	PASS
00083	-	000.01	VDC	PASS
00085	-	000.01	VDC	PASS
00087	-	000.01	VDC	PASS
00089	+	000.00	VDC	PASS
00091	+	000.00	VDC	PASS
00093	+	000.00	VDC	PASS
00095	+	000.00	VDC	PASS
00097	+	000.00	VDC	PASS
00099	+	000.00	VDC	PASS
00101	+	000.00	VDC	PASS
00103	+	000.00	VDC	PASS
00105	+	000.00	VDC	PASS
00107	+	000.00	VDC	PASS
00109	+	000.00	VDC	PASS
00111	+	000.00	VDC	PASS
00115		052525	DATA	PASS
00117		052525	DATA	PASS
00119		021042	DATA	PASS
00121		036074	DATA	PASS
00123		036074	DATA	PASS
00125		007760	DATA	PASS
00127	+	00026	MSEC	PASS
00129	+	00026	MSEC	PASS
00131	+	00025	MSEC	PASS
00133	+	00025	MSEC	PASS
00135	+	00025	MSEC	PASS
00137	+	00025	MSEC	PASS
00139	+	00025	MSEC	PASS
00141	+	00025	MSEC	PASS
00143	+	00027	MSEC	PASS
00145	+	00027	MSEC	PASS
00147	+	00027	MSEC	PASS
00149	+	00027	MSEC	PASS
00151	+	00027	MSEC	PASS
00153	+	00027	MSEC	PASS
00155	+	00027	MSEC	PASS
00157	+	00027	MSEC	PASS
00159	+	00026	MSEC	PASS
00161	+	00026	MSEC	PASS
00163	+	00026	MSEC	PASS
00165	+	00026	MSEC	PASS
00167	+	00026	MSEC	PASS
00169	+	00026	MSEC	PASS
00171	+	00026	MSEC	PASS

00052	+	023.99	VDC	PASS
00054	+	023.99	VDC	PASS
00056	+	023.94	VDC	PASS
00058	+	023.98	VDC	PASS
00060	+	024.00	VDC	PASS
00062	+	023.94	VDC	PASS
00064	+	023.95	VDC	PASS
00066	+	000.00	VDC	PASS
00068	+	000.00	VDC	PASS
00070	+	000.00	VDC	PASS
00072	+	000.00	VDC	PASS
00074	+	000.00	VDC	PASS
00076	+	000.00	VDC	PASS
00078	+	000.00	VDC	PASS
00080	+	000.00	VDC	PASS
00082	-	000.01	VDC	PASS
00084	-	000.01	VDC	PASS
00086	+	000.00	VDC	PASS
00088	+	000.00	VDC	PASS
00090	+	000.00	VDC	PASS
00092	+	000.00	VDC	PASS
00094	+	000.00	VDC	PASS
00096	+	000.00	VDC	PASS
00098	+	000.00	VDC	PASS
00100	+	000.00	VDC	PASS
00102	+	000.00	VDC	PASS
00104	+	000.00	VDC	PASS
00106	+	000.00	VDC	PASS
00108	+	000.00	VDC	PASS
00110	+	000.00	VDC	PASS
00112	+	000.00	VDC	PASS
00116		052525	DATA	PASS
00118		021042	DATA	PASS
00120		021042	DATA	PASS
00122		036074	DATA	PASS
00124		007760	DATA	PASS
00126		007760	DATA	PASS
00128	+	00026	MSEC	PASS
00130	+	00025	MSEC	PASS
00132	+	00025	MSEC	PASS
00134	+	00025	MSEC	PASS
00136	+	00025	MSEC	PASS
00138	+	00025	MSEC	PASS
00140	+	00025	MSEC	PASS
00142	+	00025	MSEC	PASS
00144	+	00027	MSEC	PASS
00146	+	00027	MSEC	PASS
00148	+	00027	MSEC	PASS
00150	+	00027	MSEC	PASS
00152	+	00027	MSEC	PASS
00154	+	00027	MSEC	PASS
00156	+	00027	MSEC	PASS
00158	+	00027	MSEC	PASS
00160	+	00026	MSEC	PASS
00162	+	00026	MSEC	PASS
00164	+	00026	MSEC	PASS
00166	+	00026	MSEC	PASS
00168	+	00026	MSEC	PASS
00170	+	00026	MSEC	PASS
00172	+	00026	MSEC	PASS

00173	+ 00026	MSEC	PASS
00175	+ 00044	MSEC	PASS
00181	+ 0070.5	USEC	PASS
00183	+ 0068.7	USEC	PASS
00185	+ 0076.3	USEC	PASS
00187	+ 0068.7	USEC	PASS
00189	+ 0066.8	USEC	PASS
00191	+ 0067.5	USEC	PASS
00193	+ 0063.1	USEC	PASS
00195	+ 0067.1	USEC	PASS
00197	+ 0063.5	USEC	PASS
00199	+ 0065.2	USEC	PASS
00201	+ 0058.8	USEC	PASS
00203	+ 0063.3	USEC	PASS
00205	+ 0067.2	USEC	PASS
00207	+ 0059.6	USEC	PASS
00209	+ 0068.1	USEC	PASS
00211	+ 0060.3	USEC	PASS
00213	+ 0069.8	USEC	PASS
00215	+ 0068.7	USEC	PASS
00217	+ 0066.5	USEC	PASS
00219	+ 0065.0	USEC	PASS
00221	+ 0069.3	USEC	PASS
00223	+ 0065.4	USEC	PASS
00225	+ 0065.6	USEC	PASS
00227	+ 0063.6	USEC	PASS
00229	+ 0069.5	USEC	PASS
00231	+ 0056.9	USEC	PASS
00233	+ 0059.9	USEC	PASS
00235	+ 0057.5	USEC	PASS
00237	+ 0065.4	USEC	PASS
00239	+ 0062.5	USEC	PASS
00241	+ 0060.6	USEC	PASS
00243	+ 0066.2	USEC	PASS
00245	+ 0060.8	USEC	PASS
00247	+ 0064.4	USEC	PASS
00249	+ 0063.6	USEC	PASS
00251	+ 0060.2	USEC	PASS
00253	+ 0070.9	USEC	PASS
00255	+ 0063.3	USEC	PASS
00257	+ 0063.3	USEC	PASS
00259	+ 0066.4	USEC	PASS
00261	+ 0066.9	USEC	PASS
00263	+ 0063.6	USEC	PASS
00265	+ 0066.8	USEC	PASS
00267	+ 0062.9	USEC	PASS
00269	+ 0070.4	USEC	PASS
00271	+ 0061.9	USEC	PASS
00273	+ 0059.0	USEC	PASS
00275	+ 0066.1	USEC	PASS
00277	<3.0 VDC		PASS
00279	<3.0 VDC		PASS
00281	<3.0 VDC		PASS
00283	<3.0 VDC		PASS
00285	<3.0 VDC		PASS
00287	<3.0 VDC		PASS
00289	<3.0 VDC		PASS
00291	<3.0 VDC		PASS
00293	<3.0 VDC		PASS
00295	<3.0 VDC		PASS

00174	+ 00026	MSEC	PASS
00180	+ 0024.6	USEC	PASS
00182	+ 0024.4	USEC	PASS
00184	+ 0026.3	USEC	PASS
00186	+ 0024.8	USEC	PASS
00188	+ 0015.4	USEC	PASS
00190	+ 0015.3	USEC	PASS
00192	+ 0014.4	USEC	PASS
00194	+ 0014.9	USEC	PASS
00196	+ 0013.2	USEC	PASS
00198	+ 0014.2	USEC	PASS
00200	+ 0013.6	USEC	PASS
00202	+ 0014.8	USEC	PASS
00204	+ 0014.2	USEC	PASS
00206	+ 0013.9	USEC	PASS
00208	+ 0016.2	USEC	PASS
00210	+ 0014.1	USEC	PASS
00212	+ 0014.3	USEC	PASS
00214	+ 0013.1	USEC	PASS
00216	+ 0014.7	USEC	PASS
00218	+ 0015.8	USEC	PASS
00220	+ 0014.7	USEC	PASS
00222	+ 0014.7	USEC	PASS
00224	+ 0015.9	USEC	PASS
00226	+ 0015.2	USEC	PASS
00228	+ 0013.7	USEC	PASS
00230	+ 0013.7	USEC	PASS
00232	+ 0014.0	USEC	PASS
00234	+ 0013.8	USEC	PASS
00236	+ 0015.6	USEC	PASS
00238	+ 0014.2	USEC	PASS
00240	+ 0014.7	USEC	PASS
00242	+ 0014.6	USEC	PASS
00244	+ 0014.4	USEC	PASS
00246	+ 0013.2	USEC	PASS
00248	+ 0014.1	USEC	PASS
00250	+ 0014.0	USEC	PASS
00252	+ 0014.2	USEC	PASS
00254	+ 0013.6	USEC	PASS
00256	+ 0014.2	USEC	PASS
00258	+ 0015.2	USEC	PASS
00260	+ 0014.4	USEC	PASS
00262	+ 0013.6	USEC	PASS
00264	+ 0014.0	USEC	PASS
00266	+ 0013.8	USEC	PASS
00268	+ 0015.2	USEC	PASS
00270	+ 0014.5	USEC	PASS
00272	+ 0013.9	USEC	PASS
00274	+ 0014.9	USEC	PASS
00276	<3.0 VDC		PASS
00278	<3.0 VDC		PASS
00280	<3.0 VDC		PASS
00282	<3.0 VDC		PASS
00284	<3.0 VDC		PASS
00286	<3.0 VDC		PASS
00288	<3.0 VDC		PASS
00290	<3.0 VDC		PASS
00292	<3.0 VDC		PASS
00294	<3.0 VDC		PASS
00296	<3.0 VDC		PASS

ORIGINAL PAGE IS
OF POOR QUALITY

00297	<3.0 VDC	PASS	00298	<3.0 VDC	PASS
00299	<3.0 VDC	PASS	00300	<3.0 VDC	PASS
00301	<3.0 VDC	PASS	00302	<3.0 VDC	PASS
00303	<3.0 VDC	PASS	00304	<3.0 VDC	PASS
00305	<3.0 VDC	PASS	00306	<3.0 VDC	PASS
00307	<3.0 VDC	PASS	00308	<3.0 VDC	PASS
00309	<3.0 VDC	PASS	00310	<3.0 VDC	PASS
00311	<3.0 VDC	PASS	00312	<3.0 VDC	PASS
00313	<3.0 VDC	PASS	00314	<3.0 VDC	PASS
00315	<3.0 VDC	PASS	00316	<3.0 VDC	PASS
00317	<3.0 VDC	PASS	00318	<3.0 VDC	PASS
00319	<3.0 VDC	PASS	00320	<3.0 VDC	PASS
00321	<3.0 VDC	PASS	00322	<3.0 VDC	PASS
00323	<3.0 VDC	PASS	00324	137 042104 5 0	PASS
00325	137 104210 5 0	PASS	00326	137 030060 5 0	PASS
00327	137 000000 5 0	PASS	00328	137 146314 5 0	PASS
00329	137 052525 5 0	PASS	00330	137 125252 5 0	PASS
00331	137 000000 5 0	PASS	00332	137 000000 5 0	PASS
00333	137 000000 5 0	PASS	00334	137 000000 5 0	PASS
00335	137 000000 5 0	PASS	00336	137 000002 5 1	PASS
00337	137 000002 5 1	PASS	00338	137 177775 5 1	PASS
00339	137 000000 5 0	PASS	00340	137 146314 5 0	PASS
00341	137 052525 5 0	PASS	00342	137 125252 5 0	PASS
00343	137 000000 5 0	PASS			

PROM SEQUENCE NOT PERFORMED!

*ARE MANUAL SCOPE TESTS TO BE PERFORMED (Y/N)? NO

END OF TEST

TEST ACCEPTED BY: 12:43PM ?

ORIGINAL PAGE IS
OF POOR QUALITY

APPENDIX VIII

LISTING OF PAPER TAPE DATA
USED TO PROGRAM SEQUENCE MEMORY

0 1100	046100
0 1101	040100
0 1102	051500
0 1103	040077
0 1104	044101
0 1105	051510
0 1106	044100
0 1107	040106
0 1110	040110
0 1111	047102
0 1112	037104
0 1113	052110
0 1114	046133
0 1115	040106
0 1116	052110
0 1117	040060
0 1120	044104
0 1121	052111
0 1122	044102
0 1123	040101
0 1124	040111
0 1125	047110
0 1126	037100
0 1127	052113
0 1130	046100
0 1131	040106
0 1132	052513
0 1133	040113
0 1134	044100
0 1135	052513
0 1136	044120
0 1137	040106
0 1140	040113
0 1141	047137
0 1142	037101
0 1143	052113
0 1144	046040
0 1145	040100
0 1146	053100
0 1147	040100
0 1150	044100
0 1151	053100
0 1152	044100
0 1153	040100
0 1154	040100
0 1155	047100
0 1156	037100
0 1157	052100
0 1160	046100
0 1161	040100
0 1162	053500
0 1163	040100
0 1164	044500
0 1165	040100
0 1166	044100
0 1167	040100
0 1170	040100
0 1171	047100
0 1172	023100
0 1173	042100
0 1174	046500
0 1175	031100
0 1176	040100
0 1177	046500

0 1200 026100
0 1201 027100
0 1202 045500
0 1203 031500
0 1204 020500
0 1205 040100
0 1206 044500
0 1207 040100
0 1210 044100
0 1211 040100
0 1212 040100
0 1213 041500
0 1214 042500
0 1215 045500
0 1216 000100
0 1217 000100
0 1220 000100
0 1221 000100
0 1222 000100
0 1223 000100
0 1224 000100
0 1225 000100
0 1226 000100
0 1227 000100
0 1230 000100
0 1231 000100
0 1232 000100
0 1233 000100
0 1234 000100
0 1235 000100
0 1236 000100
0 1237 000100
0 1240 000100
0 1241 000100
0 1242 000100
0 1243 000100
0 1244 000100
0 1245 000100
0 1246 000100
0 1247 041500
0 1250 044100
0 1251 036100
0 1252 040100
0 1253 040100
0 1254 037500
0 1255 046100
0 1256 036100
0 1257 024100
0 1260 044100
0 1261 050500
0 1262 040100
0 1263 040100
0 1264 044500
0 1265 040500
0 1266 044100
0 1267 040100
0 1270 040100
0 1271 047100
0 1272 023100
0 1273 042100
0 1274 046500
0 1275 031100
0 1276 040100
0 1277 046500

ORIGINAL PAGE IS
OF POOR QUALITY

0	1300	026100
0	1301	027100
0	1302	045500
0	1303	031500
0	1304	020500
0	1305	040100
0	1306	044500
0	1307	040500
0	1310	044100
0	1311	040100
0	1312	040100
0	1313	046100
0	1314	036100
0	1315	024100
0	1316	044100
0	1317	051100
0	1320	040100
0	1321	041100
0	1322	057100
0	1323	057500
0	1324	044100
0	1325	040100
0	1326	041100
0	1327	044500
0	1330	052500
0	1331	026100
0	1332	044500
0	1333	027100
0	1334	040500
0	1335	041100
0	1336	057100
0	1337	046500
0	1340	044100
0	1341	040100
0	1342	040100
0	1343	046100
0	1344	053100
0	1345	057100
0	1346	045100
0	1347	040100
0	1350	040500
0	1351	041100
0	1352	057100
0	1353	041100
0	1354	044100
0	1355	040100
0	1356	041100
0	1357	045100
0	1360	044100
0	1361	042500
0	1362	046500
0	1363	027500
0	1364	031500
0	1365	041100
0	1366	057100
0	1367	040100
0	1370	044100
0	1371	040100
0	1372	040100
0	1373	047100
0	1374	052100
0	1375	023100
0	1376	047500
0	1377	040100

0 1400	057100
0 1401	041101
0 1402	057102
0 1403	042513
0 1404	044106
0 1405	040060
0 1406	040073
0 1407	044400
0 1410	050000
0 1411	043000
0 1412	045400
0 1413	022000
0 1414	032000
0 1415	040400
0 1416	045000
0 1417	040000
0 1420	044000
0 1421	040000
0 1422	040000
0 1423	046000
0 1424	021400
0 1425	032000
0 1426	044400
0 1427	031400
0 1430	045000
0 1431	041000
0 1432	057000
0 1433	045400
0 1434	044000
0 1435	040000
0 1436	040400
0 1437	044400
0 1440	053000
0 1441	023000
0 1442	045400
0 1443	032000
0 1444	041400
0 1445	040400
0 1446	042400
0 1447	050000
0 1450	044000
0 1451	040000
0 1452	040000
0 1453	047000
0 1454	053000
0 1455	026400
0 1456	047000
0 1457	057400
0 1460	045000
0 1461	040400
0 1462	042400
0 1463	030000
0 1464	044000
0 1465	040000
0 1466	040000
0 1467	047000
0 1470	057000
0 1471	022400
0 1472	047400
0 1473	030000
0 1474	045000
0 1475	041000
0 1476	057000
0 1477	045000

0 1500 044000
0 1501 040000
0 1502 040000
0 1503 046000
0 1504 022400
0 1505 022000
0 1506 044400
0 1507 040000
0 1510 032400
0 1511 041000
0 1512 043000
0 1513 030000
0 1514 044000
0 1515 040000
0 1516 041000
0 1517 046400
0 1520 026400
0 1521 047000
0 1522 045400
0 1523 026000
0 1524 022000
0 1525 041000
0 1526 057000
0 1527 040400
0 1530 044000
0 1531 040000
0 1532 042000
0 1533 046400
0 1534 026000
0 1535 046400
0 1536 047000
0 1537 040000
0 1540 040501
0 1541 040535
0 1542 054477
0 1543 044100
0 1544 044100
0 1545 040100
0 1546 040103
0 1547 046523
0 1550 026464
0 1551 036104
0 1552 046061
0 1553 032463
0 1554 026000
0 1555 042400
0 1556 024000
0 1557 036000
0 1560 000000
0 1561 000000
0 1562 000000
0 1563 000000
0 1564 000000
0 1565 000000
0 1566 000000
0 1567 000000
0 1570 000000
0 1571 000000
0 1572 000000
0 1573 000000
0 1574 000000
0 1575 000000
0 1576 000000
0 1577 000000

ORIGINAL PAGE IS
OF POOR QUALITY

0 1600	000000
0 1601	000000
0 1602	000000
0 1603	000000
0 1604	000000
0 1605	000000
0 1606	000000
0 1607	000000
0 1610	000000
0 1611	041400
0 1612	044400
0 1613	036000
0 1614	040000
0 1615	040000
0 1616	037400
0 1617	046000
0 1620	024000
0 1621	040000
0 1622	045400
0 1623	040000
0 1624	040000
0 1625	040400
0 1626	041000
0 1627	040000
0 1630	044000
0 1631	040000
0 1632	040000
0 1633	047000
0 1634	022000
0 1635	046000
0 1636	045000
0 1637	026000
0 1640	022400
0 1641	044000
0 1642	042000
0 1643	027000
0 1644	045000
0 1645	031000
0 1646	027400
0 1647	040400
0 1650	041000
0 1651	040000
0 1652	044000
0 1653	040000
0 1654	040000
0 1655	047000
0 1656	050000
0 1657	040000
0 1660	044000
0 1661	040000
0 1662	040000
0 1663	041000
0 1664	057000
0 1665	056000
0 1666	044000
0 1667	040000
0 1670	040000
0 1671	047000
0 1672	043000
0 1673	020000
0 1674	044000
0 1675	023400
0 1676	022400
0 1677	046400

ORIGINAL PAGE IS
OF POOR QUALITY

0 1700	030000
0 1701	040000
0 1702	044000
0 1703	040000
0 1704	040000
0 1705	041103
0 1706	057107
0 1707	053074
0 1710	044100
0 1711	040100
0 1712	040077
0 1713	044500
0 1714	053110
0 1715	023103
0 1716	044110
0 1717	022500
0 1720	031100
0 1721	040516
0 1722	055046
0 1723	050104
0 1724	044115
0 1725	040062
0 1726	040103
0 1727	046500
0 1730	046510
0 1731	033104
0 1732	046110
0 1733	026100
0 1734	045100
0 1735	041116
0 1736	057124
0 1737	043046
0 1740	044117
0 1741	040115
0 1742	040054
0 1743	046500
0 1744	026510
0 1745	037105
0 1746	045510
0 1747	041500
0 1750	057500
0 1751	040516
0 1752	050324
0 1753	040046
0 1754	044117
0 1755	040115
0 1756	040455
0 1757	047100
0 1760	056110
0 1761	057110
0 1762	045110
0 1763	040100
0 1764	045100
0 1765	040514
0 1766	050135
0 1767	040054
0 1770	044114
0 1771	040100
0 1772	041521
0 1773	047100
0 1774	052110
0 1775	057115
0 1776	045510

0	2000	045100
0	2001	041115
0	2002	042456
0	2003	050130
0	2004	044110
0	2005	040051
0	2006	040070
0	2007	044500
0	2010	053110
0	2011	042116
0	2012	046110
0	2013	020500
0	2014	032100
0	2015	041116
0	2016	042447
0	2017	054116
0	2020	044110
0	2021	040045
0	2022	040137
0	2023	044500
0	2024	053110
0	2025	057517
0	2026	044510
0	2027	031500
0	2030	024500
0	2031	040516
0	2032	043106
0	2033	030121
0	2034	044117
0	2035	040042
0	2036	040053
0	2037	046500
0	2040	033510
0	2041	043120
0	2042	046110
0	2043	031500
0	2044	045100
0	2045	041116
0	2046	043076
0	2047	020124
0	2050	044114
0	2051	040100
0	2052	043521
0	2053	044500
0	2054	053110
0	2055	057121
0	2056	044110
0	2057	023500
0	2060	030100
0	2061	041116
0	2062	057076
0	2063	056524
0	2064	044114
0	2065	040100
0	2066	041122
0	2067	046100
0	2070	037110
0	2071	041122
0	2072	045110
0	2073	030100
0	2074	031500
0	2075	040516
0	2076	052476
0	2077	024124

APPENDIX IX

LISTING OF SEQUENCE MEMORY

CONTENTS FROM

DATA BUS

FOLLOWING TEST SEQUENCE

PER PAR

6. 01. 82

FROM CONTENTS PRIMARY

00001 137 052040 5 0
00003 137 017541 5 0
00005 137 143500 5 0
00007 137 170600 5 0
00009 137 177001 5 0
00011 137 137401 5 0
00013 137 167401 5 0
00015 137 175401 5 0
00017 137 044104 5 0
00019 137 044102 5 0
00021 137 040111 5 0
00023 137 037100 5 0
00025 137 046100 5 0
00027 137 052513 5 0
00029 137 044100 5 1
00031 137 044120 5 0
00033 137 040113 5 1
00035 137 037101 5 1
00037 137 046040 5 0
00039 137 053100 5 1
00041 137 044100 5 1
00043 137 044100 5 1
00045 137 040100 5 0
00047 137 037100 5 0
00049 137 046100 5 0
00051 137 053500 5 0
00053 137 044500 5 0
00055 137 044100 5 1
00057 137 040100 5 0
00059 137 023100 5 0
00061 137 046500 5 1
00063 137 040100 5 0
00065 137 026100 5 0
00067 137 045500 5 1
00069 137 020500 5 1
00071 137 044500 5 0
00073 137 044100 5 1
00075 137 040100 5 0
00077 137 042500 5 0
00079 137 000100 5 1
00081 137 000100 5 1
00083 137 000100 5 1
00085 137 000100 5 1
00087 137 000100 5 1
00089 137 000100 5 1
00091 137 000100 5 1
00093 137 000100 5 1
00095 137 000100 5 1
00097 137 000100 5 1
00099 137 000100 5 1
00101 137 000100 5 1
00103 137 000100 5 1
00105 137 044100 5 1
00107 137 040100 5 0
00109 137 037500 5 1
00111 137 036100 5 1
00113 137 044100 5 1
00115 137 040100 5 0

00002 137 025141 5 0
00004 137 107440 5 0
00006 137 161541 5 0
00008 137 124301 5 0
00010 137 077401 5 0
00012 137 157401 5 0
00014 137 173401 5 0
00016 137 176401 5 0
00018 137 052111 5 0
00020 137 040101 5 1
00022 137 047110 5 0
00024 137 052113 5 1
00026 137 040106 5 0
00028 137 040113 5 1
00030 137 052513 5 0
00032 137 040106 5 0
00034 137 047137 5 0
00036 137 052113 5 1
00038 137 040100 5 0
00040 137 040100 5 0
00042 137 053100 5 1
00044 137 040100 5 0
00046 137 047100 5 1
00048 137 052100 5 0
00050 137 040100 5 0
00052 137 040100 5 0
00054 137 040100 5 0
00056 137 040100 5 0
00058 137 047100 5 1
00060 137 042100 5 1
00062 137 031100 5 0
00064 137 046500 5 1
00066 137 027100 5 1
00068 137 031500 5 1
00070 137 040100 5 0
00072 137 040100 5 0
00074 137 040100 5 0
00076 137 041500 5 0
00078 137 045500 5 1
00080 137 000100 5 1
00082 137 000100 5 1
00084 137 000100 5 1
00086 137 000100 5 1
00088 137 000100 5 1
00090 137 000100 5 1
00092 137 000100 5 1
00094 137 000100 5 1
00096 137 000100 5 1
00098 137 000100 5 1
00100 137 000100 5 1
00102 137 000100 5 1
00104 137 041500 5 0
00106 137 036100 5 1
00108 137 040100 5 0
00110 137 046100 5 0
00112 137 024100 5 1
00114 137 050500 5 0
00116 137 040100 5 0

ORIGINAL PAGE IS
OF POOR QUALITY

00117	137	044500	5	0
00119	137	044100	5	1
00121	137	040100	5	0
00123	137	023100	5	0
00125	137	046500	5	1
00127	137	040100	5	0
00129	137	026100	5	0
00131	137	045500	5	1
00133	137	020500	5	1
00135	137	044500	5	0
00137	137	044100	5	1
00139	137	040100	5	0
00141	137	036100	5	1
00143	137	044100	5	1
00145	137	040100	5	0
00147	137	057100	5	0
00149	137	044100	5	1
00151	137	041100	5	1
00153	137	052500	5	1
00155	137	044500	5	0
00157	137	040500	5	1
00159	137	057100	5	0
00161	137	044100	5	1
00163	137	040100	5	0
00165	137	053100	5	1
00167	137	045100	5	0
00169	137	040500	5	1
00171	137	057100	5	0
00173	137	044100	5	1
00175	137	041100	5	1
00177	137	044100	5	1
00179	137	046500	5	1
00181	137	031500	5	1
00183	137	057100	5	0
00185	137	044100	5	1
00187	137	040100	5	0
00189	137	052100	5	0
00191	137	047500	5	0
00193	137	057100	5	0
00195	137	057102	5	1
00197	137	044106	5	1
00199	137	040073	5	0
00201	137	050000	5	0
00203	137	045400	5	0
00205	137	032000	5	1
00207	137	045000	5	1
00209	137	044000	5	0
00211	137	040000	5	1
00213	137	021400	5	1
00215	137	044400	5	1
00217	137	045000	5	1
00219	137	057000	5	1
00221	137	044000	5	0
00223	137	040400	5	0
00225	137	053000	5	0
00227	137	045400	5	0
00229	137	041400	5	1
00231	137	042400	5	1
00233	137	044000	5	0
00235	137	040000	5	1

00118	137	040500	5	1
00120	137	040100	5	0
00122	137	047100	5	1
00124	137	042100	5	1
00126	137	031100	5	0
00128	137	046500	5	1
00130	137	027100	5	1
00132	137	031500	5	1
00134	137	040100	5	0
00136	137	040500	5	1
00138	137	040100	5	0
00140	137	046100	5	0
00142	137	024100	5	1
00144	137	051100	5	0
00146	137	041100	5	1
00148	137	057500	5	1
00150	137	040100	5	0
00152	137	044500	5	0
00154	137	026100	5	0
00156	137	027100	5	1
00158	137	041100	5	1
00160	137	046500	5	1
00162	137	040100	5	0
00164	137	046100	5	0
00166	137	057100	5	0
00168	137	040100	5	0
00170	137	041100	5	1
00172	137	041100	5	1
00174	137	040100	5	0
00176	137	045100	5	0
00178	137	042500	5	0
00180	137	027500	5	0
00182	137	041100	5	1
00184	137	040100	5	0
00186	137	040100	5	0
00188	137	047100	5	1
00190	137	023100	5	0
00192	137	040100	5	0
00194	137	041101	5	0
00196	137	042513	5	1
00198	137	040060	5	1
00200	137	044400	5	1
00202	137	043000	5	1
00204	137	022000	5	0
00206	137	040400	5	0
00208	137	040000	5	1
00210	137	040000	5	1
00212	137	046000	5	1
00214	137	032000	5	1
00216	137	031400	5	0
00218	137	041000	5	0
00220	137	045400	5	0
00222	137	040000	5	1
00224	137	044400	5	1
00226	137	023000	5	1
00228	137	032000	5	1
00230	137	040400	5	0
00232	137	050000	5	0
00234	137	040000	5	1
00236	137	047000	5	0

00237	137	053000	5	0
00239	137	047000	5	0
00241	137	045000	5	1
00243	137	042400	5	1
00245	137	044000	5	0
00247	137	040000	5	1
00249	137	057000	5	1
00251	137	047400	5	1
00253	137	045000	5	1
00255	137	057000	5	1
00257	137	044000	5	0
00259	137	040000	5	1
00261	137	022400	5	1
00263	137	044400	5	1
00265	137	032400	5	0
00267	137	043000	5	1
00269	137	044000	5	0
00271	137	041000	5	0
00273	137	026400	5	0
00275	137	045400	5	0
00277	137	022000	5	0
00279	137	057000	5	1
00281	137	044000	5	0
00283	137	042000	5	0
00285	137	026000	5	1
00287	137	047000	5	0
00289	137	040501	5	0
00291	137	054477	5	0
00293	137	044100	5	1
00295	137	040103	5	0
00297	137	026464	5	1
00299	137	046061	5	0
00301	137	026000	5	1
00303	137	024000	5	0
00305	137	000000	5	0
00307	137	000000	5	0
00309	137	000000	5	0
00311	137	000000	5	0
00313	137	000000	5	0
00315	137	000000	5	0
00317	137	000000	5	0
00319	137	000000	5	0
00321	137	000000	5	0
00323	137	000000	5	0
00325	137	000000	5	0
00327	137	000000	5	0
00329	137	000000	5	0
00331	137	044400	5	1
00333	137	040000	5	1
00335	137	037400	5	0
00337	137	024000	5	0
00339	137	045400	5	0
00341	137	040000	5	1
00343	137	041000	5	0
00345	137	044000	5	0
00347	137	040000	5	1
00349	137	022000	5	0
00351	137	045000	5	1
00353	137	022400	5	1
00355	137	042000	5	0

00238	137	026400	5	0
00240	137	057400	5	0
00242	137	040400	5	0
00244	137	030000	5	0
00246	137	040000	5	1
00248	137	047000	5	0
00250	137	022400	5	1
00252	137	030000	5	0
00254	137	041000	5	0
00256	137	045000	5	1
00258	137	040000	5	1
00260	137	046000	5	1
00262	137	022000	5	0
00264	137	040000	5	1
00266	137	041000	5	0
00268	137	030000	5	0
00270	137	040000	5	1
00272	137	046400	5	0
00274	137	047000	5	0
00276	137	026000	5	1
00278	137	041000	5	0
00280	137	040400	5	0
00282	137	040000	5	1
00284	137	046400	5	0
00286	137	046400	5	0
00288	137	040000	5	1
00290	137	040535	5	1
00292	137	044100	5	1
00294	137	040100	5	0
00296	137	046523	5	0
00298	137	036104	5	0
00300	137	032463	5	0
00302	137	042400	5	1
00304	137	036000	5	0
00306	137	000000	5	0
00308	137	000000	5	0
00310	137	000000	5	0
00312	137	000000	5	0
00314	137	000000	5	0
00316	137	000000	5	0
00318	137	000000	5	0
00320	137	000000	5	0
00322	137	000000	5	0
00324	137	000000	5	0
00326	137	000000	5	0
00328	137	000000	5	0
00330	137	041400	5	1
00332	137	036000	5	0
00334	137	040000	5	1
00336	137	046000	5	1
00338	137	040000	5	1
00340	137	040000	5	1
00342	137	040400	5	0
00344	137	040000	5	1
00346	137	040000	5	1
00348	137	047000	5	0
00350	137	046000	5	1
00352	137	026000	5	1
00354	137	044000	5	0
00356	137	027000	5	0

00357	137 045000	5 1
00359	137 027400	5 1
00361	137 041000	5 0
00363	137 044000	5 0
00365	137 040000	5 1
00367	137 050000	5 0
00369	137 044000	5 0
00371	137 040000	5 1
00373	137 057000	5 1
00375	137 044000	5 0
00377	137 040000	5 1
00379	137 043000	5 1
00381	137 044000	5 0
00383	137 022400	5 1
00385	137 030000	5 0
00387	137 044000	5 0
00389	137 040000	5 1
00391	137 057107	5 1
00393	137 044100	5 1
00395	137 040077	5 1
00397	137 053110	5 0
00399	137 044110	5 0
00401	137 031100	5 0
00403	137 055046	5 1
00405	137 044115	5 0
00407	137 040103	5 0
00409	137 046510	5 0
00411	137 046110	5 1
00413	137 045100	5 0
00415	137 057124	5 0
00417	137 044117	5 1
00419	137 040054	5 0
00421	137 026510	5 0
00423	137 045510	5 0
00425	137 057500	5 1
00427	137 050524	5 0
00429	137 044117	5 1
00431	137 040455	5 0
00433	137 056110	5 0
00435	137 045110	5 1
00437	137 045100	5 0
00439	137 050135	5 1
00441	137 044114	5 1
00443	137 041521	5 0
00445	137 052110	5 1
00447	137 045510	5 0
00449	137 045100	5 0
00451	137 042456	5 1
00453	137 044110	5 0
00455	137 040070	5 0
00457	137 053110	5 0
00459	137 046110	5 1
00461	137 032100	5 0
00463	137 042447	5 1
00465	137 044110	5 0
00467	137 040137	5 1
00469	137 053110	5 0
00471	137 044510	5 1
00473	137 024500	5 0
00475	137 043106	5 0

00358	137 031000	5 1
00360	137 040400	5 0
00362	137 040000	5 1
00364	137 040000	5 1
00366	137 047000	5 0
00368	137 040000	5 1
00370	137 040000	5 1
00372	137 041000	5 0
00374	137 056000	5 0
00376	137 040000	5 1
00378	137 047000	5 0
00380	137 020000	5 1
00382	137 023400	5 0
00384	137 046400	5 0
00386	137 040000	5 1
00388	137 040000	5 1
00390	137 041103	5 1
00392	137 053074	5 0
00394	137 040100	5 0
00396	137 044500	5 0
00398	137 023103	5 0
00400	137 022500	5 0
00402	137 040516	5 0
00404	137 050104	5 0
00406	137 040062	5 0
00408	137 046500	5 1
00410	137 033104	5 0
00412	137 026100	5 0
00414	137 041116	5 0
00416	137 043046	5 0
00418	137 040115	5 1
00420	137 046500	5 1
00422	137 037105	5 0
00424	137 041500	5 0
00426	137 040516	5 0
00428	137 040046	5 0
00430	137 040115	5 1
00432	137 047100	5 1
00434	137 057110	5 1
00436	137 040100	5 0
00438	137 040514	5 1
00440	137 040054	5 0
00442	137 040100	5 0
00444	137 047100	5 1
00446	137 057115	5 1
00448	137 045100	5 0
00450	137 041115	5 0
00452	137 050130	5 1
00454	137 040051	5 0
00456	137 044500	5 0
00458	137 042116	5 0
00460	137 020500	5 1
00462	137 041116	5 0
00464	137 054116	5 1
00466	137 040045	5 0
00468	137 044500	5 0
00470	137 057517	5 1
00472	137 031500	5 1
00474	137 040516	5 0
00476	137 030121	5 1

00477	137	044117	5	1
00479	137	040053	5	1
00481	137	033510	5	1
00483	137	046110	5	1
00485	137	045100	5	0
00487	137	043076	5	0
00489	137	044114	5	1
00491	137	043521	5	1
00493	137	053110	5	0
00495	137	044110	5	0
00497	137	030100	5	1
00499	137	057076	5	0
00501	137	044114	5	1
00503	137	041122	5	1
00505	137	037110	5	1
00507	137	045110	5	1
00509	137	031500	5	1
00511	137	052476	5	1

00478	137	040042	5	1
00480	137	046500	5	1
00482	137	043120	5	1
00484	137	031500	5	1
00486	137	041116	5	0
00488	137	020124	5	0
00490	137	040100	5	0
00492	137	044500	5	0
00494	137	057121	5	0
00496	137	023500	5	1
00498	137	041116	5	0
00500	137	056524	5	0
00502	137	040100	5	0
00504	137	046100	5	0
00506	137	041122	5	1
00508	137	030100	5	1
00510	137	040516	5	0
00512	137	024124	5	1

APPENDIX X

FLEXIBLE MDM ACCEPTANCE TEST
PROCEDURE COMPUTER OUTPUT LISTING

ORIGINAL PAGE IS
OF POOR QUALITY

0000 H TIME(S) TESTED
 (DISPLAY), (CHANGE) OR (START) ? CHANGE
 H D M SERIAL# - 0001
 PRINT ALL ? (YES) OR (NO) - YES
 BUS - (PRIMARY), (SECONDARY) OR (BOTH) - PRIMARY
 CONFIGURATION - 1 THRU C OR M(AP) - MAP
 MODULE# MODULE NAME NEW MODULE NAME

0	?????????	DIS (ORB)
1	?????????	DO - 20
2	?????????	DO - 20
3	?????????	DI - 20
4	?????????	DC I N
5	?????????	DOS (ORB)
6	?????????	DI - 20
7	?????????	D C U
8	?????????	?????????
9	?????????	N 1 L
A	?????????	N 1 L
B	?????????	N 1 L
C	?????????	N 1 L
D	?????????	N 1 L
E	?????????	N 1 L
F	?????????	N 1 L

0000 H TIME(S) TESTED
 (DISPLAY), (CHANGE) OR (START) ? CHANGE
 H D M SERIAL# - 0001
 PRINT ALL ? (YES) OR (NO) - YES
 BUS - (PRIMARY), (SECONDARY) OR (BOTH) - PRIMARY
 CONFIGURATION - 1 THRU C OR M(AP) - MAP
 MODULE# MODULE NAME NEW MODULE NAME

0	DIS (ORB)	
1	DO - 20	
2	DO - 20	
3	DI - 20	
4	DC I N	
5	DOS (ORB)	
6	DI - 20	S D 1/0
7	D C U	
8	?????????	N 1 L
9	N 1 L	
A	N 1 L	
B	N 1 L	
C	N 1 L	
D	N 1 L	
E	N 1 L	
F	N 1 L	

FMDM1 Acc. Test
Dry Run
12-14-77

0000 H TIME(S) TESTED
D(ISPLAY), C(HANGE) OR S(TART) ? DISPLAY
T.P.# - T4025545
TAPE# - PD4028041-00
M D M SERIAL# - 0001
PRINT - ALL
BUS - PRIMARY
CONFIGURATION -

MODULE#	MODULE NAME
0	DI5 (ORB)
1	DO - 28
2	DO - 28
3	DI - 28
4	DC I N
5	DO5 (ORB)
6	S D I/O
7	D C O
8	N I L
9	N I L
A	N I L
B	N I L
C	N I L
D	N I L
E	N I L
F	N I L

0000 H TIME(S) TESTED
D(ISPLAY), C(HANGE) OR S(TART) ? START
M D M SERIAL# - 0001
TEST - FMDM DRY RUN
DATE & TIME - 12/14/77

CORE MODULES

0001	11111 00000000000100011 101 11000000	PASS
0002	11111 0111110111110011 101 11000000	PASS
0003	11111 1000000000000000 101 10000000	PASS
0004	11111 1011010010000000 101 10000000	PASS
0005	11111 0000000000000000 101 10000000	PASS
0006	11111 0100101101000000 101 10000000	PASS
0007	11111 0111111111100000 101 11000000	PASS
0008	11111 0000000000100110 101 11000000	PASS

DI5 (ORB); IOM# 00

0001	11111 0000111111110000 101 10000000	PASS
0002	11111 11110000000001111 101 10000000	PASS
0003	11111 0000111100001111 101 10000000	PASS
0004	11111 1111000011110000 101 10000000	PASS
0005	11111 1111000011110000 101 10000000	PASS

ORIGINAL PAGE IS
OF POOR QUALITY

0006 11111 0000111100001111 101 11000000 PASS
0007 11111 0000000000000000 101 11000000 PASS

DO - 285 IOM# 01

0001 11111 0101010101010101 101 10000000 PASS
0002 11111 0011001100110011 101 10000000 PASS
0003 11111 1010101010101010 101 11000000 PASS
0004 11111 0000000000000000 101 11000000 PASS
0005 11111 1010101010101010 101 10000000 PASS
0006 11111 1100110011001100 101 10000000 PASS
0007 11111 0101010101010101 101 11000000 PASS
0008 11111 0000000000000000 101 11000000 PASS
0009 11111 0000000000000000 101 10000000 PASS
0010 11111 0000000000000000 101 10000000 PASS
0011 11111 1111111111111101 101 11000000 PASS
0012 11111 0000000000000000 101 11000000 PASS

DO - 285 IOM# 02

0001 11111 0101010101010101 101 10000000 PASS
0002 11111 0011001100110011 101 10000000 PASS
0003 11111 1010101010101010 101 11000000 PASS
0004 11111 0000000000000000 101 11000000 PASS
0005 11111 1010101010101010 101 10000000 PASS
0006 11111 1100110011001100 101 10000000 PASS
0007 11111 0101010101010101 101 11000000 PASS
0008 11111 0000000000000000 101 11000000 PASS
0009 11111 0000000000000000 101 10000000 PASS
0010 11111 0000000000000000 101 10000000 PASS
0011 11111 1111111111111101 101 11000000 PASS
0012 11111 0000000000000000 101 11000000 PASS

DI - 285 IOM# 03

0001 11111 0000111111110000 101 10000000 PASS
0002 11111 1111000000001111 101 10000000 PASS
0003 11111 0000111100001111 101 10000000 PASS
0004 11111 1111000011110000 101 10000000 PASS
0005 11111 1111000011110000 101 10000000 PASS
0006 11111 0000111100001111 101 11000000 PASS
0007 11111 0000000000000000 101 11000000 PASS
0008 11111 0000000000000000 101 11000000 FAIL
0009 11111 0000000000000000 101 11000000 FAIL
0010 11111 0000000000000000 101 11000000 PASS

DC 1 N3 IOM# 04

0001 11111 0011001001000000 101 10000000 PASS
0002 11111 1111111110000000 101 10000000 PASS
0003 11111 1100110110000000 101 10000000 PASS
0004 11111 0000000001000000 101 10000000 PASS
0005 11111 1100110110000000 101 10000000 PASS
0006 11111 0000000001000000 101 10000000 PASS
0007 11111 0011001001000000 101 10000000 PASS
0008 11111 1111111101000000 101 10000000 PASS
0009 11111 1100110110000000 101 10000000 PASS
0010 11111 0000000001000000 101 10000000 PASS
0011 11111 0011001001000000 101 10000000 PASS
0012 11111 1111111111000000 101 10000000 PASS
0013 11111 0011001001000000 101 10000000 PASS
0014 11111 1111111110000000 101 10000000 PASS
0015 11111 1100110110000000 101 10000000 PASS
0016 11111 0000000001000000 101 10000000 PASS
0017 11111 1100110110000000 101 10000000 PASS
0018 11111 0000000001000000 101 10000000 PASS

0019	11111	0011001001000000	101	10000000	PASS
0020	11111	1111111111000000	101	10000000	PASS
0021	11111	0011001001000000	101	10000000	PASS
0022	11111	1111111111000000	101	10000000	PASS
0023	11111	1100110110000000	101	10000000	PASS
0024	11111	0000000001000000	101	10000000	PASS
0025	11111	0011001001000000	101	10000000	PASS
0026	11111	1111111111000000	101	10000000	PASS
0027	11111	1100110110000000	101	10000000	PASS
0028	11111	0000000001000000	101	10000000	PASS
0029	11111	1100110110000000	101	10000000	PASS
0030	11111	0000000001000000	101	10000000	PASS
0031	11111	0011001001000000	101	10000000	PASS
0032	11111	1111111111000000	101	10000000	PASS
0033	11111	1100110111000000	101	10000000	PASS
0034	11111	0000000001000000	101	10000000	PASS
0035	11111	0011001001000000	101	10000000	PASS
0036	11111	1111111111000000	101	10000000	PASS
0037	11111	0011001001000000	101	10000000	PASS
0038	11111	1111111111000000	101	10000000	PASS
0039	11111	1100110110000000	101	10000000	PASS
0040	11111	0000000001000000	101	10000000	PASS
0041	11111	0011001001000000	101	10000000	PASS
0042	11111	1111111111000000	101	10000000	PASS
0043	11111	1100110110000000	101	10000000	PASS
0044	11111	0000000001000000	101	10000000	PASS
0045	11111	1100110110000000	101	10000000	PASS
0046	11111	0000000001000000	101	10000000	PASS
0047	11111	0011001001000000	101	10000000	PASS
0048	11111	1111111111000000	101	10000000	PASS
0049	11111	0011001001000000	101	10000000	PASS
0050	11111	1111111111000000	101	10000000	PASS
0051	11111	1100110110000000	101	10000000	PASS
0052	11111	0000000001000000	101	10000000	PASS
0053	11111	1100110110000000	101	10000000	PASS
0054	11111	0000000001000000	101	10000000	PASS
0055	11111	0011001001000000	101	10000000	PASS
0056	11111	1111111111000000	101	10000000	PASS
0057	11111	1100110110000000	101	10000000	PASS
0058	11111	0000000001000000	101	10000000	PASS
0059	11111	0011001001000000	101	10000000	PASS
0060	11111	1111111111000000	101	10000000	PASS
0061	11111	0011001001000000	101	10000000	PASS
0062	11111	1111111111000000	101	10000000	PASS
0063	11111	1100110110000000	101	10000000	PASS
0064	11111	0000000001000000	101	11000000	PASS
0065	11111	0000000000000000	101	11000000	PASS

D05 (ORB): IOM# 05

0001	11111	0101010101010101	101	10000000	PASS
0002	11111	0011001100110011	101	10000000	PASS
0003	11111	1010101010101010	101	11000000	PASS
0004	11111	0000000000000000	101	11000000	PASS
0005	11111	1111111111111111	101	11000000	PASS
0006	11111	1111111111111111	101	11000000	PASS
0007	11111	0101010101010101	101	11000000	PASS
0008	11111	0000000000000000	101	11000000	PASS

ORIGINAL PAGE IS
OF POOR QUALITY

0001	11111	1010101010101010	101	10000000	PASS
0002	11111	0101010101010101	101	10000000	PASS
0003	11111	1010101010101010	101	10000000	PASS
0004	11111	0101010101010101	101	10000000	PASS
0005	11111	1010101010101010	101	10000000	PASS
0006	11111	0101010101010101	101	10000000	PASS
0007	11111	1010101010101010	101	10000000	PASS
0008	11111	0101010101010101	101	11000000	PASS
0009	11111	0000000000000000	101	11000000	PASS

D C 03 10M# 07

0001	11111	1010101101000000	101	10000000	PASS
0002	11111	0101010010000000	101	10000000	PASS
0003	11111	1010101110000000	101	10000000	PASS
0004	11111	0101001111000000	101	10000000	PASS
0005	11111	1010101110000000	101	10000000	PASS
0006	11111	0101010001000000	101	10000000	PASS
0007	11111	1010101010000000	101	10000000	PASS
0008	11111	0101010001000000	101	10000000	PASS
0009	11111	1010101101000000	101	10000000	PASS
0010	11111	0101010001000000	101	10000000	PASS
0011	11111	1010101110000000	101	10000000	PASS
0012	11111	0101010011000000	101	10000000	PASS
0013	11111	1010101110000000	101	10000000	PASS
0014	11111	0101010001000000	101	10000000	PASS
0015	11111	1010101101000000	101	10000000	PASS
0016	11111	0101010001000000	101	11000000	PASS
0017	11111	0000000000000000	101	11000000	PASS
0018	11111	0101010001000000	101	10000000	PASS
0019	11111	1010101110000000	101	10000000	PASS
0020	11111	0101010001000000	101	10000000	PASS
0021	11111	1010101110000000	101	10000000	PASS
0022	11111	0101001111000000	101	10000000	PASS
0023	11111	1010101100000000	101	10000000	PASS
0024	11111	0101010100000000	101	10000000	PASS
0025	11111	1010101110000000	101	10000000	PASS
0026	11111	0101010001000000	101	10000000	PASS
0027	11111	1010101101000000	101	10000000	PASS
0028	11111	0101010001000000	101	10000000	PASS
0029	11111	1010101110000000	101	10000000	PASS
0030	11111	0101010001000000	101	10000000	PASS
0031	11111	1010101101000000	101	10000000	PASS
0032	11111	0101010010000000	101	10000000	PASS
0033	11111	1010101110000000	101	11000000	PASS
0034	11111	0000000000000000	101	11000000	PASS

0001 H TIME(S) TESTED
D(ISPLAY), C(HANGE) OR S(TART) ?

ORIGINAL PAGE IS
OF POOR QUALITY